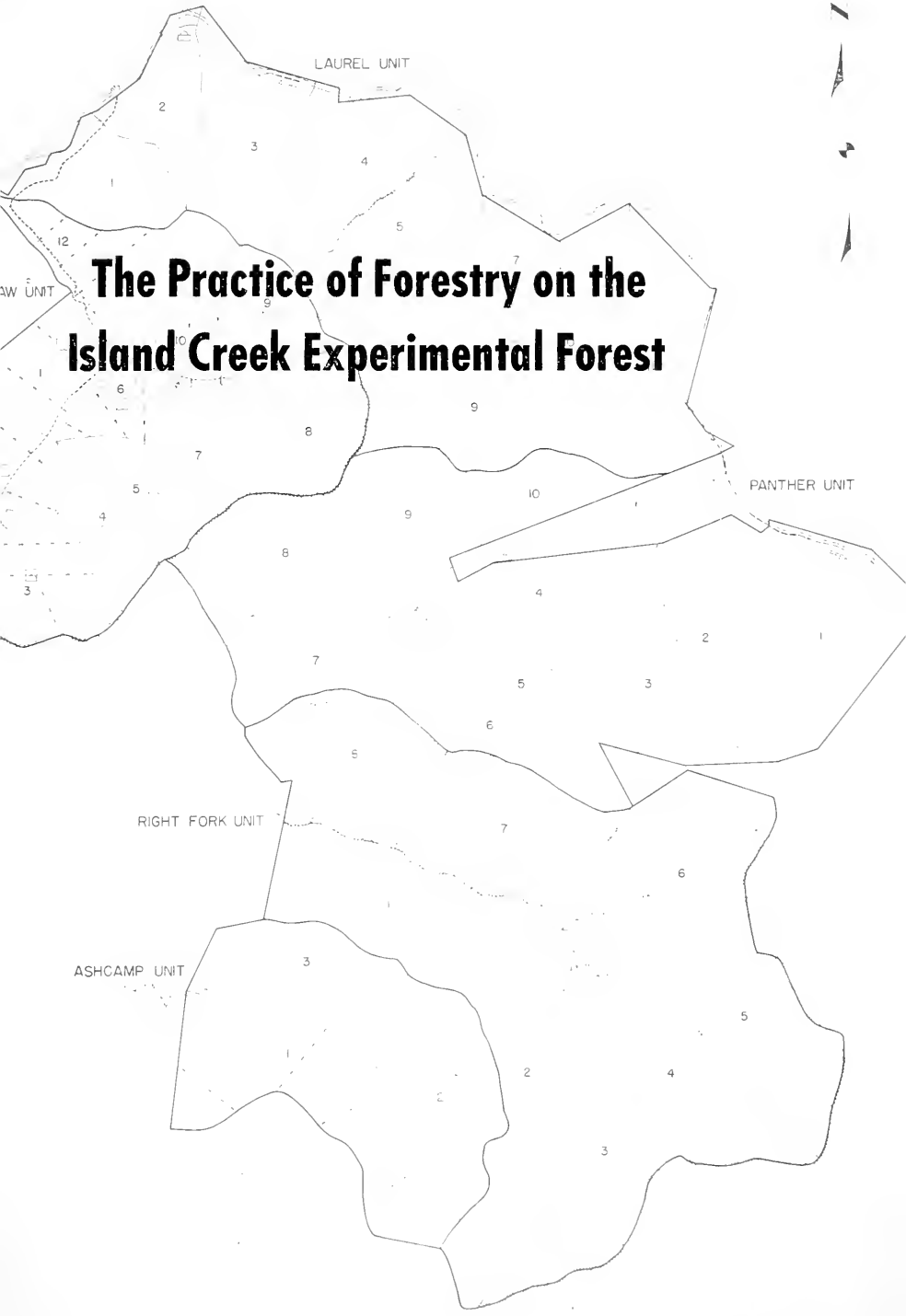

The Practice of Forestry on the Island Creek Experimental Forest

BULLETIN 587 FEBRUARY 1970

WEST VIRGINIA UNIVERSITY AGRICULTURAL EXPERIMENT STATION

Acknowledgments

The authors express their sincere appreciation to the many people who contributed to the organization and operation of the Island Creek Experimental Forest.

Without the cooperation of University personnel and Island Creek Coal Company officials, too numerous to mention separately, the project would never have progressed.

To Herbert Heesch who assisted with many of the office computations and to Dr. Kenneth Carvell who prepared the table of woody plants found on the Forest, special mention is due, as it is to Dr. John Hamilton who provided photographic assistance and to Mrs. John Bell, wife of the resident forester, who many times provided secretarial and other assistance on an entirely voluntary basis.

The lumber marketing talent of C. B. Robinson, contractor from 1953 through 1956, and the experimental cooperativeness of Raymond Carey, contractor from 1957 on, is appreciatively recognized.

The Authors

Allen W. Goodspeed is Forester. John F. Bell was Resident Forester, Island Creek Experimental Forest, at the time of the study.

West Virginia University
Agricultural Experiment Station
College of Agriculture and Forestry
A. H. VanLandingham, Director
Morgantown

The Practice of Forestry on the Island Creek Experimental Forest

Allen W. Goodspeed and John F. Bell

INTRODUCTION

Profitable forest management for timber production depends primarily on markets for timber products. This being true, the market is the first determinant of management goals. Yet few forest tracts in West Virginia are managed with specific markets in view. Actually, management for sustained timber production alone, regardless of salability, is rather uncommon.

In 1951 the Forestry Division of West Virginia University, with the cooperation of the Island Creek Coal Company, initiated a research project of timber management for the market demands in southern West Virginia to determine: (1) the present and prospective timber-products demands of available markets, (2) mine timber needs, and (3) marketable products the hardwood forest types of southern West Virginia can best produce.

Also, four alternative systems of silvicultural treatment were studied to determine which would best produce timber of the desired specifications and would be preferred for practical consideration of harvesting and processing.

This publication presents the results obtained from cutting over the entire area for the first time and sets the stage for future work on the effect of the four silvicultural treatments on future timber production.

AN APPROACH TO THE FOREST MANAGEMENT PROBLEM

Southern West Virginia Coal Fields Area; Forests and Ownership

A recent publication of West Virginia University's Bureau of Business Research shows 20 contiguous counties as making up the southern coal fields area of the State (Thompson 1964). All but three of the counties were active coal producers in 1963. Fourteen of the counties, the producing heart of the southern coal fields, also constituted the southern geographic sampling stratum, or unit, for the 1961 national survey of West Virginia's forest resources (Ferguson 1964). The 14 counties are Boone, Clay, Fayette, Greenbrier, Kanawha, Logan, McDowell, Mercer, Mingo, Monroe, Nicholas, Raleigh, Summers, and Wyoming. The many similarities in this 14-county area permit a collective consideration of their forestry problems and, in fact, this was done in a study of timber industry opportunities carried out by the Northeastern Forest Experiment Station (Hagenstein 1964). In Hagenstein's study the 14 counties comprised the "Beckley area."

It may also be noted that of the 32 largest coal producing companies in the State in 1964, 24 operated in the 14-county unit (West Virginia Department of Mines, Annual Report 1964). Furthermore, at least 54 per cent of the privately owned commercial land area is held in individual ownerships of 500 acres or more. This high concentration of large private ownership is a rather unusual feature of the southern geographic unit.

Exclusive of 122,400 acres of National Forest, the southern geographic unit has a gross land area of 4,904,200 acres of which 4,063,000 acres, or 83 per cent, is classed as commercial forest land. This commercial area, in 1961, had a total cubic foot volume of slightly over four billion feet, or, in terms of sawtimber, 10,741 million board feet. Most of this area, 98.9 per cent, is privately owned.

On a per acre basis, the average saw timber volume is approximately 2,600 board feet, the net annual increment 85 board feet, and in 1960 the cut was 50 board feet. These sawtimber stand and increment figures are low by any reasonable forest management standard. In addition, the timber quality is not high. However, they represent the forest picture as it exists and are necessarily the point of departure for the development of a forest management program.

In short, the southern part of the State has a high proportion of commercial forest land, almost all privately owned, and much of it is in fairly large ownerships. The topography is rugged and this probably precludes extensive agricultural development. Although deteriorated by past cuttings and fires, the forests exist and appear to be the logical surface use of the land area. This opinion gains support when one realizes that good forests, aside from their value as wood producers, are generally considered an asset to programs of watershed protection, recreation, and fish and wildlife production.

If the desirability of forest production on forest land is conceded, the problem becomes one of how to bring it about. In particular, how might an industrial owner handle his land so as to make it an asset to him while at the same time contributing to the general welfare of the locality? This problem is vast and complex, involving human attitudes and convictions in addition to material factors, but this does not mean that the problem is insolvable. The imitative quality of people suggests that a working demonstration of forestry might result in emulation by others and thus, by growth, become an accepted procedure.

To a forester, the area, with its concentration of large private ownerships, presents a real opportunity for forest management. The industrial landowner, however, may not be quite so enthusiastic. If he is a coal operator, he is occupied and fully engaged in the business of mining, and this is what he knows. He may not even be aware of the possibilities of a forest management program, or if he is he may have only a poor idea of the requirements for such an enterprise or the benefits that might be derived from it. Should he seek to inform himself by observing what other industrial owners are doing with ancillary forest management programs he will not easily find much of the information he needs. He will soon dis-

cover that past cuttings and fires have depleted his forest stands in both quantity and quality, and that fires are still frequent. He might well decide that, on the basis of the information readily available to him, a program of forest management and development is entirely too uncertain a proposition for his company to undertake.

A Selected Approach to the Forest Management Problem

Personnel of the Division of Forestry at West Virginia University, aware of the industrial forest management problem in the southern part of the State, became actively concerned with seeking some workable solutions shortly after the end of World War II. It was apparent that the available extension services of the University, oriented chiefly towards the small woodland owner, were not, and properly could not, supply the information needed to promote industrial forest management. Professional forestry consultants were available and rendered such services as were demanded by their clients. Unfortunately, those owners unaware of possible forestry values on their holdings were not inclined to utilize professional forestry services.

A promising start on the problem of industrial forest management might be made if a large private owner would make available a suitable area for an actual forest operation. This operation would be designed to determine if a typical southern West Virginia forest could be cut in a manner that would create good conditions for future growth and production and it should result, at least, in the recovery of direct operating costs and depreciation. Success in this effort would demonstrate the feasibility of forestry on the minimum basis that a private owner could be expected to accept. Should positive stumpage values emerge, the opportunity for management on a commercial basis might even prove attractive.

Implicit in the expression "forest management" is the conception of a sustained yield output. As defined by the Society of American Foresters this is "the management of a forest property for continuous production with the aim of achieving, at the earliest practicable time, an approximate balance between net growth and harvest, either by annual or somewhat longer periods" (Forestry Terminology, S.A.F. 1958).

At the time objectives were being set up it was believed that an economically satisfactory manufacturing and marketing unit would require a forest area of from 20 to 30 thousand acres. Confirmation of this belief was provided later in a Northeastern Forest Experiment Station study of timber opportunities (Hagenstein 1964).

A lumber manufacturing plant with a capacity of 20,000 board feet per day seemed suitable for West Virginia. Such a plant, operating 250 days a year, would produce five million board feet a year and should be competitively efficient.

To supply such a plant on a sustained yield basis, and assuming an average annual growth under management of 200 board feet per acre per year, would require about 25,000 fully productive acres and, allowing for non-productive land, a gross area somewhat larger. Furthermore, average growth and growing stock are at present deficient in amount and

quality in southern West Virginia and this would necessitate an even larger area to sustain operations during the time the forest was being rebuilt. Consideration of these facts suggested that an attempt to launch a full scale independent forest operation would not be a feasible way to get at the forest management problem.

The area objective finally adopted for the study was to select a tract of from two to four thousand acres, industrially owned, and available for the establishment of an experimental forest on a cooperative basis. Such an area would be large enough to permit logging, manufacture, and sales of forest products on a commercial basis, yet not so large as to transcend the operating abilities of the West Virginia Agricultural Experiment Station. True, an annual sustained yield from the experimental forest would have to be foregone. More importantly, however, different stand management methods could be established and observed on a commercial basis and the product output would be sufficient to provide a reasonable prospect of entering the market competitively. A good performance in the market was thought to be of primary importance as a means of inducing large private owners to initiate forest management programs of their own.

Cooperators in a Forestry Program

With the general objectives of the study in mind, a search was begun for a suitable industrial owner and area. This was carried out by the personnel of the Division of Forestry at West Virginia University. As the major industry in the region was the coal business the search was conducted among this type of landowner. During 1949, 1950, and 1951 various coal companies were approached, the proposed study explained, and their cooperation solicited. When a company showed interest, a preliminary examination of their holdings was made.

Among the owners expressing an interest on first contact, there were various conditions that, upon examination, eliminated most of them from further consideration. One otherwise promising prospect was soon to be out of coal and therefore understandably unwilling to assume any long time forestry commitments. Other companies were already undertaking some forestry work, either with their own foresters or by using consulting services. To this type of owner, obviously, no forceful approach was made.

Attention was finally centered on the Island Creek Coal Company with head offices at Huntington, West Virginia. As this company became the cooperating industrial landowner for the forest management study, some descriptive comments follow.

The Island Creek Coal Company of Maine was organized in 1910, and by 1915 had taken over the property of the United States Coal and Oil Company. The latter corporation had shipped its first coal from Holden, in Logan County, late in 1904 and coal production had been continuous since that time.

Since the formation of the Island Creek Coal Company, development of coal production and distribution has been actively and successfully pursued. Production has been entirely from deep mines, and, to date, has excluded stripping operations.

By 1964 the company had become the largest non-captive coal producer in West Virginia. Operating in Logan, McDowell, Mingo, and Wyoming counties the parent corporation, exclusive of affiliates, produced 13 million tons of coal in 1964 (Annual Report, W. Va. Dept. of Mines 1964). This was a little over nine per cent of the State's total coal production for the year.

During 1964 the company acquired the properties of the West Kentucky Coal Corporation and at the same time underwent a major corporate reorganization. Now known as the Island Creek Coal Company, a Delaware Corporation, its main offices have been moved to Cleveland, Ohio, and the original Company is now called the Island Creek Division with offices in Huntington, West Virginia.

At the time the company was first considered as a likely prospect for a forest management program it operated in Logan and Mingo counties, where, according to the 1950 report of the West Virginia Department of Mines, it produced in that year some 6,166,000 tons of coal, 4.7 per cent of the State's total and 24.3 per cent of the Logan and Mingo county production. Current production was backed up by ample coal reserves.

A particularly favorable aspect of the Island Creek Coal Company was its ownership, in fee simple, of many thousands of acres in Logan and Mingo counties, thus having been able to prevent the complete destruction of its forest lands and to control the surface use of its holdings.

The president of the company in 1950 was Raymond E. Salvatti, an alumnus of West Virginia University, a member of the University Board of Governors, and a man with a genuine interest in the possibilities of forest management as a desirable surface use for the lands of his company.

When Island Creek Coal Company officials were first approached in 1950, they immediately proved receptive to the idea of providing an experimental forest area.

Meanwhile the Director of the University's Division of Forestry had already employed a graduate forester with considerable forest utilization experience to become resident forester at whatever location might be chosen for the study. This man at once undertook to look over the Island Creek holdings in order to select a rather typical southern West Virginia forest area.

While the forest was being selected, a memorandum of understanding was prepared and discussed with Company officials and at the same time a suitable research project in the West Virginia Agricultural Experiment Station was formulated. The result was a 10-year agreement signed by the University and the Coal Company which became effective in October 1951.

Under the terms of the agreement a 3,188-acre tract in Mingo County was established as the Island Creek Experimental Forest and in December 1951 a professional forester moved to Holden, about 20 miles from the forest, and took up his duties as resident forester-in-charge.

A summary of the situation as it existed on January 1, 1952, with operations about to commence, follows. Events are in chronological order.

1. A project entitled "Timber Management for the Market Demands

in Southern West Virginia Forests" had been drawn up and approved as R & M No. 31 in the West Virginia Agricultural Experiment Station. A project forester had been assigned to this operation.

2. A 3,188-acre tract on the land of the Island Creek Coal Company in Mingo County, and within 20 miles by road from Holden, had been tentatively selected. This tract was to be known as the Island Creek Experimental Forest.

The Island Creek Experimental Forest

As finally established, the Island Creek Experimental Forest embraced 3,188 acres located in the northeastern part of Mingo County. Paw Paw Branch at the entrance to the Paw Paw logging unit lies on the western edge of the Forest about two miles, by road, southeast of Dingess, and 18 miles from Holden. By air, over the major mountain ridge on the Logan-Mingo county line, this point is only eight miles from Holden. Its latitude is 37°51′ north, and its longitude 82°12′ west.

The long dimension of the tract running north and south is about 3.5 miles, while its width is 2.5 miles in an east-west direction (Figure 1).

The topography of the tract can best be described by the following quotation taken from a West Virginia Geological Survey report on Logan and Mingo counties. "The hillsides are broken frequently by narrow flat benches, marking the deposits of shale and coal that separate the massive ledges of sandstone that compose the greater part of the surface rocks. These benches are not readily seen from the valleys as their narrowness and the forest that usually covers the hills give the appearance of a slope that is uniformly steep. The tops of the ridges are sharp being frequently only wide enough for narrow trails along them. There are numerous low divides and corresponding sharp points that rise several hundred feet above them."

Elevations on the Forest range from 840 feet at Laurel Fork stream on the northwest boundary of the Laurel unit to 1,792 feet at the high points on the Jeep trail between the Panther and Laurel logging units. Altitude gains of 600 feet may be made in only 1,200 feet of horizontal travel. This is a 50 per cent grade, and in places it is even steeper.

Five principal streams drain the area, all tributaries of Laurel Fork which flows southwest from the northwestern corner of the forest. Panther Branch flows out of the Forest to the east, Billy Branch to the north, Paw Paw Branch to the northwest, the Right Fork of Laurel Fork and Ashcamp Branch to the east. Each of these tributaries provides access to a portion of the Forest and, in general, each portion is separated from its neighbors by an intervening high ridge.

Soils of northeastern Mingo County are predominantly of the Muskingum series, derived from sandstones and shales. On the narrow ridges loam and sandy loams of the DeKalb and Ramsey types occur. Soils are thin, but present, on the ridge tops and increase in depth as one descends the steep slopes. In the coves and valley bottoms alluvial soils of a silty character are found. Existing mature trees indicate that even on the ridge tops soils are adequate for good forest growth.

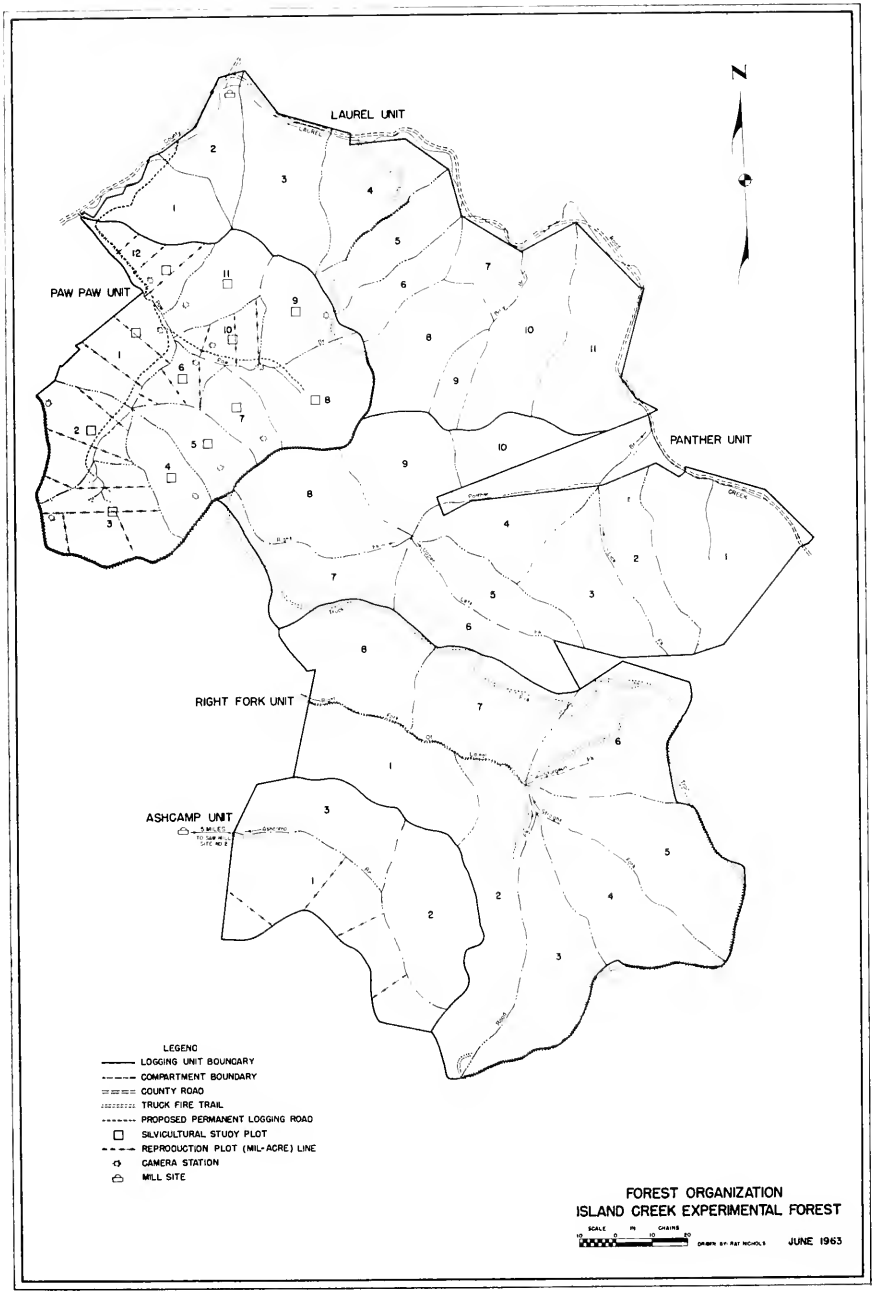

FIGURE 1. Map of the Island Creek Experimental Forest.

Published climatic data (Climate and Man 1941) show that in Logan, a few miles east of the Experimental Forest, the average January temperature was 39°F, and for July 76°F. Annual precipitation, based on a 28-year period, was 48 inches and only in the months of September, October, and November did it fall below three inches. The last frost occurred about the middle of April and the average growing season was 193 days.

According to a Geological Survey report on forestry and wood industries (A.B. Brooks 1911), early logging in Mingo County removed much of the best timber, such as yellow-poplar and black walnut. The logs were moved by rafts on the Tug Fork River. By 1893 the Norfolk and Western Railroad had reached Williamson. This, and other railroad developments, encouraged the building of steam sawmills and the rapid removal of the good sawtimber. In general, hickory, beech, birch, and maple were not taken. By 1910 all but an estimated 8,200 acres of the Mingo County virgin forest had been removed and the big lumber boom was over, while at the same time coal companies and other non-resident owners had acquired title to some 200,000 acres of the cut-over forest lands.

During the last 50 years the forests of the County have been subjected to cutting where patches of good timber have been found, and to a series of cuts for mine materials as the coal companies developed. None of these cuts seem to have been carried out with any consideration of continuous forest production nor, until recently, has any effective effort been made to prevent and control forest fires. This is, at present, an extremely serious matter, and no good program of forest management can be expected to develop where the forest is subjected to severe and repeated burning.

So far as insects and disease are concerned the Forest is typical of southwestern West Virginia. The chestnut is gone, a victim of the chestnut blight (**Endothia parasitica** (Murr.) A. & A.), but this species was never as important as a component of the Mingo County area as it was in other parts of the State. Oak wilt (**Ceratocystis fagacearum** (Bretz) Hunt) has been found on the Forest, but not in great amounts. No conditions are known to exist that would unduly jeopardize the prospects for a successful forest management program.

For the purposes of a research and demonstration forest the Island Creek Experimental Forest was considered fairly representative of the forest conditions prevailing in southern West Virginia. Its residual forest cover contained about 11 million board feet of volume (International ¼ inch rule) in trees 12 inches d.b.h. and up. Its topography, accessibility, and past history were all similar to other forest areas in the region.

As classified by the Society of American Foresters (Forest Cover Types of North America 1964) the prevailing cover type designation is oak-hickory with yellow-poplar and its type variants also important. Small patches of many hardwood forest types can be identified on the Forest.

On the ridge tops and upper slopes, particularly those facing south and west, chestnut oaks, black oaks, scarlet oaks, and hickories are common, and some pitch pine is present; while on the lower slopes, particularly those facing north and east, red and white oaks and yellow-

poplars are found. In the stream bottoms a yellow-poplar and hemlock type occurs and in small coves and sheltered areas there is a wide variety of mixed hardwood type variations. American beech is generally present throughout the Forest.

Based on an inventory of the Laurel, Panther, Ashcamp, and Right Fork logging drainages, or logging units, made after the project was started but before any cutting took place, the species making up at least one per cent of the estimated net volume 12 inches d.b.h. and up is shown in Table 1. Data from the Paw Paw unit is not included in this table because a change in the method of species grouping made the Paw Paw records incompatible with those from the rest of the Forest.

All oaks, yellow-poplar, and basswood accounted for 56 per cent of the total sawtimber volume.

FOREST PRODUCTION OPERATIONS

Silvicultural Methods Employed

Before starting cutting operations, and in order to determine how cutting should be done, the systems that might be suitable for forest production over a long period of years were considered.

In order to permit a comparative evaluation of forest production methods both even-aged and uneven-aged systems were required, as hardwoods may be handled either way. Furthermore, under each general type of management, reproduction may be affected by the method of mature timber removal.

After careful consideration, four silvicultural systems were selected to be developed and tested on the Forest, each identified by the method used to secure forest reproduction. These methods were:

1. **Seed-tree method (S.T.)** — This method produces an even-aged

TABLE 1

Species Composition by Volume Before Cutting on 1,872 Acres of the Island Creek Experimental Forest — Trees 12 Inches D.B.H. and up, International Quarter Inch Rule.

Species	Per Cent of Forest Volume
Red and Black oaks	25
Beech	16
Yellow-poplar	16
Hickories	10
Chestnut oak	8
Other hardwoods	6
Black gum	5
Hard maple	5
Basswood	4
Hemlock (includes ½ per cent pitch pine)	3
White oaks (excludes chestnut oak)	2
TOTAL	100

stand and is suitable for light seeded and light demanding species. The existing stand is removed except for seed trees of desirable species which are left to provide the reproduction.

2. **Shelterwood method (SH)** — This method also produces an even-aged stand. It is suitable for heavy seeded and light demanding species. The old stand is removed in two or three successive cuts over a total period of five to ten years, depending on the time required to establish reproduction firmly on the area.

3. **Selection method 10-year cycle (S-10)** — A method to produce an uneven-aged stand. It is suitable for many species if carefully applied. Old trees are removed from the stand individually or in small groups at approximately 10-year intervals.

4. **Selection method, 20-year cycle (S-20)** — This is similar to the preceding selection method except that the individual cuts are heavier and the interval of return is about 20 years.

The foregoing procedures, while not exhaustive, were felt to represent fairly well a wide enough variety of stand management methods to permit the development of valid comparisons over a long period of time. No illusion existed that each method could be established at once on the Forest, where the immediate problem was to put a run-down and cut-over area in better shape for future growth by what might well be called a conditioning cut. A consideration of the silvicultural systems to be developed was necessary, however, in order to give direction and purpose to the actual conditioning cuts.

Experimental Pattern

In developing the pattern for silvicultural management a deliberate effort was made to assign the treatment methods on the basis of the current stand conditions and adaptability to a particular method. In other words, every effort was made to take advantage of any head start provided by the past history of the forest stands. For example, in assigning the treatment methods to be developed, an old even-aged stand with a high proportion of yellow-poplar would be selected for the seed-tree method, while an uneven-aged oak stand would be assigned to one of the selection options. Approximately even-aged oak stands were assigned to the shelterwood method.

One further point, frequently overlooked, should be presented in connection with the silvicultural management of forest stands. This is the rotation, or number of years a particular stand will productively occupy a specific area. Knowledge of this parameter is of great help in estimating the allowable cut in stands that are being developed by partial cutting methods. For instance, in handling an uneven-aged mixed oak stand with a 20-year interval between cuts and a rotation of 100 years it can be argued that about one-fifth of the stand area should be opened up at each cut. While the cut can be determined by volume considerations alone, in a research approach there is no real reason to eliminate this additional check which is available if rotation is known.

For the Island Creek Experimental Forest a rotation of 100 years was

tentatively selected for the oak-hickory stands and 60 to 70 years for the yellow-poplar type. These are rotations near maximum mean annual board foot increment and will produce large timber under management. While they may need revision as the work progresses, they did serve the guiding purpose previously discussed, and they permitted cutting to be initiated without delay.

Forest Organization

Reference to the map of the 3,188-acre Experimental Forest (Figure 1) will make clear the plan of organization used in the application of the silvicultural methods.

The Forest was first divided into five logging units. In general, each unit was bounded by surrounding ridge tops or the Forest boundary and had its own particular avenue of access, frequently a stream draining the unit. This method of subdivision ensured that all logging could be done downhill, an important consideration in view of the logging methods that were to be used.

The units, in turn, were divided into compartments ranging in size from 21 to 143 acres and with an average size of 72 acres. The individual compartment was the parcel on which a particular silvicultural method was employed, and on which detailed records were kept.

In general, compartments ran from the stream bottoms to the ridge tops. Thus they included many cover type variations, although usually a particular type group such as oak-hickory or yellow-poplar predominated. It was not considered practicable or meaningful to attempt to identify separately small patches of different cover types within a compartment. The physical boundary of each compartment was marked by a stake at the ridge top and at the stream bottom. The boundary itself usually meandered down a minor ridge from the high point.

Table 2 shows the results of the area subdivision.

The diverse objectives established for the Forest, and the practical limitations on the means to be used in attaining them, presented a real problem in formulating a satisfactory experimental pattern.

From the standpoint of long time forest development and the comparison of silvicultural methods, the compartment was the ultimate samp-

TABLE 2

Logging Units on the Island Creek Experimental Forest

Unit	Area (acres)	Total Tree Estimate Net Volume, M B.F.	No. of Comps.	Year Operated
Paw Paw	567	2,054	12	1953,54
Laurel	697	514	11	1956,57,58
Panther	747	2,008	10	1956,57,58
Ashcamp	307	1,535	3	1960,61
Right Fork	870	4,761	8	1958,59,60
TOTAL	3,188	10,872	44	

ling unit, while from the point of view of logging, and milling, the logging unit was the logical basis for computing results. For example, stumpage appraisals were, per force, made by logging units, not by compartments, although it was subsequently possible to approximate the stumpage income by compartments.

Furthermore, neither logging units nor compartments were uniform in size or other physical attributes. Also, it was the apparent wish of the Company that a sawmill go into operation on a commercial operating basis as quickly as possible.

All these considerations suggested that an informal system of replicated silvicultural methods be established on the area so that each stand production method to be tested would appear at least once in each logging unit.

As previously mentioned, particular treatments were more or less randomly assigned with a deliberate effort made to take advantage of the stand conditions existing at the time the silvicultural method was assigned. Thus, in the Paw Paw unit, compartment 1 with its large amount of yellow-poplar, basswood, and red oak seemed especially suited to the seed-tree method and was so treated, while compartment 12 with its high proportion of oak and hickory volume was assigned to the shelterwood method.

After weighing all the factors involved the experimental pattern presented in Table 3 was adopted to guide the forest production research in the Experimental Forest. Figure 1, the forest map, shows the lay-out on the ground.

Logging Procedures

Timber cutting operations were initiated in the Paw Paw unit in November 1953. The site for the semi-portable mill, to which all logs were delivered, was at the junction of the Laurel Fork road and the old county road from Dingess to Lenore, about 1.25 miles south of Dingess. This location was within 3.5 miles of all the timber in the Paw Paw, Laurel, and Panther units, for which it served as the point of manufacture.

In 1958 the mill was moved to a location a mile east of the community of Rapp and along the road following the Right Fork of Laurel Fork. Rapp is about one mile north of Lenore. This site was some five miles west of the Experimental Forest, and it was to this point that the logs from the Right Fork and Ashcamp units were taken.

Logging equipment employed was of the sort generally available and commonly used in the area. One man power saws were used for felling, trimming, and bucking in the woods, horses were used for skidding from stump to landing, and landings were constructed along temporary roads running near, or in, the creek bottoms. Skidding was strictly a down-hill operation. Skidding distance extended up to a half mile but more nearly averaged a quarter mile. At the landing the logs were decked and then rolled on to single-or double-axled trucks of 1½ to 2 tons rated capacity for transportation to the mill.

After the mill was moved to its second location in 1958 a change was made in the logging procedure. The contractor secured a small tractor-

TABLE 3

Compartments and Area Assigned to Four Silvicultural Methods on the Island Creek Experimental Forest

Logging Unit & Area (acres)	No. of Comp's.	Silvicultural Method Assigned							
		Seed Tree		Shelterwood		Selection (10)		Selection (20)	
		Comp. No.	Acres	Comp. No.	Acres	Comp. No.	Acres	Comp. No.	Acres
Paw Paw	12	1	57	2	57	5	40	4	40
567		3	77	6	23	7	31	8	78
		10	28	12	40	9	49	11	47
			162		120		120		165
Laurel	11	1	56	2	47	6	40	4	72
697		3	96	5	56	8	79	7	34
		9	21			11	105	10	91
			173		103		224		197
Panther	10	3	83	2	60	4	63	1	143
747		6	70	5	52	7	67	8	92
				9	76			10	41
			153		188		130		276
Ashcamp	3	1	135	3	74			2	98
307									
Right Fork	8	1	109	5	120	6	120	3	106
870		2	125	8	98	7	102	4	90
			234		218		222		196
FOREST TOTALS 3,188 acres	44		857		703		696		932

mounted boom loader which permitted direct loading from ground to truck and eliminated the need for landing construction. It also allowed the teamsters to drop their logs at any convenient point within 100 feet of the truck roads.

Local labor was employed for the woods operation. The pay scale, at first, was 50 cents to 75 cents per hour, but this was later raised to $1.25 per hour to comply with Federal minimum wage laws. Certain skilled men were paid more.

At this point the reader may quite possibly question the use of the equipment and procedures outlined above. It was hoped to demonstrate the feasibility of forest operations under conditions that could be emulated by any interested forest owner and without excessive investments in expensive machinery. The land-owner contemplating a forest program on his own property might well be deterred, rather than encouraged to go ahead, if he thought that initial heavy investments were required. For this reason, the decision was made to proceed with readily available equipment and methods for the woods operations.

A cut and leave tally of all trees 12 inches in diameter breast high (d.b.h.) and up was made in each compartment before it was logged. Trees were tallied by species, d.b.h., and height. Board foot volumes were determined from a tree volume table adapted from the form class tables of Mesavage and Girard and issued by the U.S. Forest Service in 1946. The International ¼ Inch Rule for form class 78 was the basis for the table used, which was arranged to facilitate deduction for apparent defect at the time the tree was measured. Both gross and net sound volume were estimated and, for the Forest as a whole, the computed net volume was 90 per cent of the measured gross. Net volumes are those referred to in this bulletin. Initially board foot volumes were also worked up by the Doyle rule, but this practice was discontinued as it did not make any particular contribution to the objectives of the project.

In the Paw Paw unit a log scaler was employed to scale all logs on the ground. It was hoped that this procedure would more accurately determine the volume produced in the woods. Had it been practical to log the Forest compartment by compartment this system would have been continued. However, the necessity for a continuous output of logs to the mill and the requirements of logging efficiency soon had logging proceeding simultaneously in more than one compartment, and even in two units at once. Under these conditions, and in view of the steep topography, it became impossible for a single scaler to get to all the trees as they were felled. This was necessary to keep the log scale separated by compartments in order to permit the determination of operating costs for each treatment area. Consequently, the log scale was abandoned in subsequent logging units and the cut and leave tally substituted as the basis for log production costs. As this tally was made by compartments no problem of separation arose.

FOREST PRODUCTION RESULTS

Logging; Areas, Methods, Volumes, Costs

Appendix Table 1 presents basic data on areas, volumes, silvicultural methods employed, felling and skidding costs, and logging units for the conditioning cut operations from November 1953 through January 1961. This is the basic data for the woods operations. A word or two of explanation may be helpful:

(1) All volume figures are by tree estimate based on the net volume table tally of the trees as they stood on the stump.

(2) The area figures in the column "acres cut" refer to the areas actually operated and may be less than the actual areas of the compartments they represent.

(3) Weighted average values are presented for each unit and for the entire area operated on the forest.

(4) Felling and skidding costs include all such elements of maintenance and woods supervision as went into the logging operation from stump to truck haul road or landing.

A word of caution is necessary with respect to the felling and skidding cost figures. While they represent the actual costs incurred they can be misleading. For example, Appendix Table 1 shows that the direct costs for the Paw Paw, Laurel, and Panther units, which were logged from the first mill set-up, run somewhat higher per M B.F. than for the Ashcamp and Right Fork units. However, the manufacturing overrun on the tree estimate volumes for these first three units ran from 24 to 29 per cent, whereas it was only seven per cent on the Ashcamp and Right Fork units. Had this latter per cent applied to the Paw Paw, Laurel, and Panther units the respective unit felling and skidding per M B.F. would have been $17.61, $26.67, and $22.34, figures more closely comparable to those of the Ashcamp and Right Fork units. The per acre felling and skidding costs would not have been affected by this adjustment.

Because of the light cut per acre taken from the Laurel unit, and the long skidding distances, a distinctly high cost per M B.F. logged resulted. Even the costs per acre were relatively high, as can be seen by comparing the $71.83 for the unit with the $51.01 cost in the Paw Paw unit where the amount cut per acre was very nearly the same. As a matter of fact, total costs for the Laurel unit almost equalled total returns and this is the only unit on which a negative profit margin to the operator occurred. On the whole, the Laurel unit was not a financially satisfactory operation.

Even when the Paw Paw, Laurel, and Panther units had their average operating costs per M B.F. adjusted for the large overrun, it was apparent that the average felling and skidding costs on the Ashcamp and Right Fork units were lower. There are plausible explanations for this difference.

In the first place, cuts per acre were distinctly larger in the latter two units and this reduced logging costs per M B.F. Thus, the average cut per acre for the first three units was 2.69 M B.F., while in the Ashcamp and Right Fork units it was 4.53 M B.F. per acre.

In addition, logging operations themselves were more efficient in

the latter two units. The boom loader was in use and the expense of log landings was no longer being incurred. The crew had become stable and adjusted to Experimental Forest requirements, and a very competent contractor was in charge of the woods work.

All the forementioned factors resulted in a better cost performance on the Ashcamp and Right Fork units, even in a time of advancing wages.

Appendix Table 2 contains the same data as the preceding table but in an arrangement designed to show differences associated with the silvicultural method employed. As all units occur in each silvicultural method group, inter-unit differences are minimized and the emphasis is on the method used.

Table 4 was prepared to show how actual performance under the different silvicultural methods compared with theoretical expectations. In this table volumes cut and felling and skidding costs are ranked in a descending order of magnitude both on an expected and actual basis.

Reference to the preceding table shows that the seed-tree method removed the greatest proportion of the standing volume, 83 per cent, and also took the heaviest cut per acre, 4.9 M B.F. As a result, it had the highest felling and skidding cost per acre but, contrary to expectations, it did not have the lowest costs per M B.F., ranking third in this respect.

The selection method with a 10-year cutting cycle took the lightest cut per acre, 2.9 M B.F. and 74 per cent of the standing volume, but it did not have the highest costs per M B.F. or the lowest costs per acre, although it ranked second and third respectively.

Perhaps a partial explanation of these differences between expectation and performance lies in the nature of the first cutting operation. The problem was to start a sequence of cuttings that would lead to the full development of the chosen methods. However, this had to be initiated on the existing forest in the poor condition in which it was found. When marking the timber the problem of what could safely be left was constantly present. As a result, and through practical necessity, these first cuttings were in the nature of conditioning cuts and the basic objective became to leave a healthy residual growing stock on the ground.

Adding to the difficulty encountered in making the first cut was the relatively light volume per acre available. Stands allotted to the seed-tree method had an original average volume of nearly 6 M B.F. per acre, while those assigned to all the other methods had about 4 M B.F. per acre. No real difficulty arose with the seed-tree method, but all the others had the problem of low volume available and the desirability of cutting about 2.5 M B.F. per acre in order to keep the logging costs at a reasonable level. The practical resolution of this dilemma was an over-all cut that, excluding the seed-tree method, took from 74 to 79 per cent of the available volume and tended to make the first cut one grand conditioning operation. The greatest gain, to date, over uncontrolled cutting, is the more favorable condition in which the forest was left for future production. The comparative test of the four silvicultural methods still lies in the future.

TABLE 4

Volume Cut and Felling and Skidding Costs Arranged in Descending Order of Rank and According to Silvicultural Method Employed — Comparison of Actual and Expected Ranks

Silvicultural Method	Volume and Per Cent Cut per Acre		Felling and Skidding Costs per Acre		Felling and Skidding Costs per M B.F.	
	Expected	Actual	Expected	Actual	Expected	Actual
Seed tree (S.T.)	1	1	1	1	4	3
Shelterwood (Sh.)	2	3	2	4	3	4
Selection, 20 year C.C. (S-20)	3	2	3	2	2	1
Selection, 10 year C.C. (S-10)	4	4	4	3	1	2

The problems described will probably be faced by other foresters as they undertake the management of southern West Virginia forests. Once fully appreciated, it is encouraging to find that they are not always incapable of being resolved.

Costs were examined on the basis of volume cut per acre in an effort to draw some useful information about felling and skidding costs from the Experimental Forest operations. As can be seen from Appendix Tables 1 and 2 each compartment provided a sampling unit for this information, although all were not weighted equally.

When felling and skidding costs per acre were plotted over volume cut per acre it appeared that a straight line would represent the relation between the two. A linear regression equation was determined by the least squares method and is presented in Figure 2-A, together with its graph and that of the individual items. From the computed costs per acre, values for costs per M B.F. were derived by dividing each per acre value by the per acre cut taken.

These derived costs per M B.F. were then plotted and are shown in Figure 2-B, along with the individual paired values.

As a check on the results, a hyperbolic curve was fitted by least squares to the original data. This produced the expression:

$$\text{Costs per M B.F.} = 13.39 + \frac{23.95}{\text{Vol. cut per acre}}$$

Computed values from this equation compare well with those previously derived, except at the extreme values.

The trend of felling and skidding costs is shown in Table 5.

TABLE 5

Trend of Felling and Skidding Costs Per Acre and Per M B.F. based on Volume Cut Per Acre on 35 Compartments Operated

Cut per Acre (M B.F.)	Costs per Acre (Dollars)	Costs per M B.F. (Dollars)
1.0	$ 41.17	$ 41.17
1.5	46.98	31.32
2.0	52.80	26.40
2.5	58.62	23.45
3.0	64.43	21.48
3.5	70.24	20.07
4.0	76.06	19.02
4.5	81.88	18.20
5.0	87.69	17.45
5.5	93.50	17.00
6.0	99.32	16.55
6.5	105.14	16.18
7.0	110.95	15.85
7.5	116.76	15.57
8.0	122.58	15.32

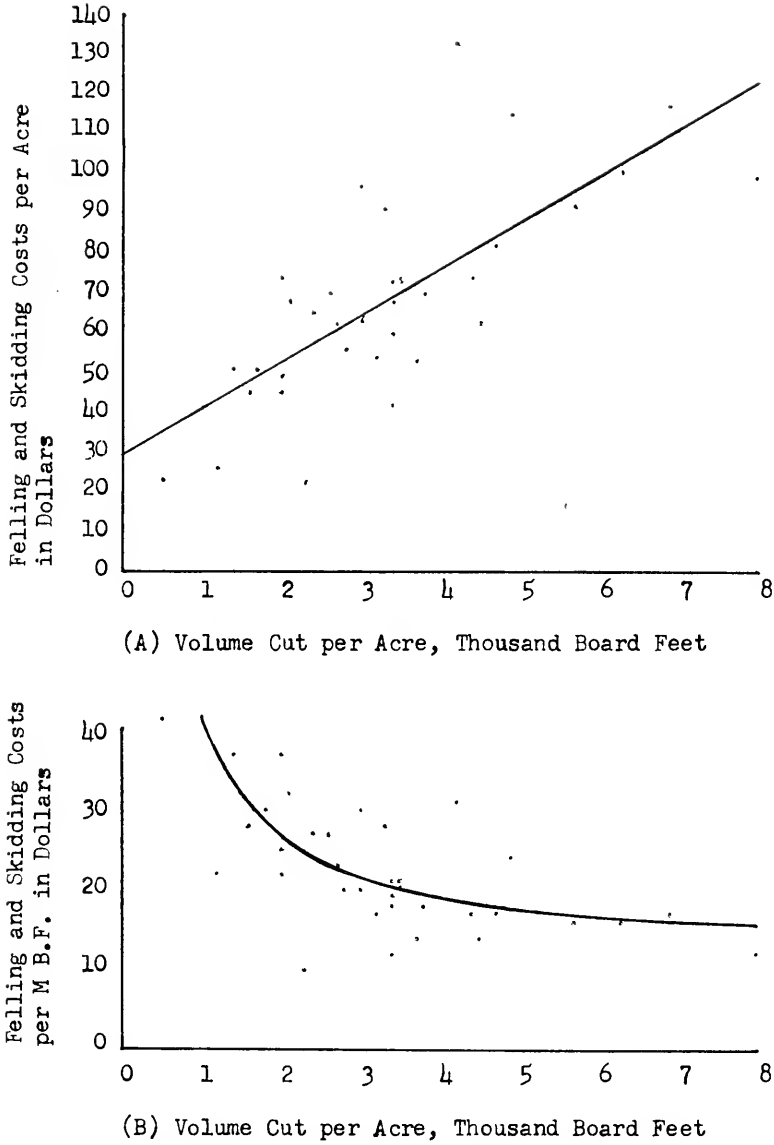

FIGURE 2. Trend of Felling and Skidding Costs per Acre and per M B. F.

A. Costs per Acre = (11.63) (Cut per Acre) + 29.54
Least Squares Fit.

B. Derived from (A). Costs per Acre Divided by Cut per Acre.

From the table and figure it can be seen that the logging costs per acre increase by a uniform amount of $5.82 for each increase in cut per acre of 500 B.F. Costs per M B.F., however, is a decreasing value, dropping rapidly as the cut per acre increases. When the cut per acre reaches 2.5 M B.F. the cost per M B.F. is $23.45 and it decreases only $8.13 when the cut per acre rises to eight M B.F. On the other hand, when the per acre cut drops from 2.5 to 1 M B.F. the felling and skidding cost rises to $41.17, an increase of $17.72, which is incurred over a much smaller range in volume cut per acre. It is not hard to understand why loggers have been reluctant to operate at extremely low levels of cut per acre, if these figures fairly well represent the situation.

Volume Cut by Species Groups

Table 6 shows the volume cut by species groups and logging units for this operation.

Inspection of the Table shows that nearly half the volume cut, 46 per cent, came from the Right Fork unit, and that for the Forest as a whole, the oak group was the most important volume constituent, providing 33 per cent of the cut. Nineteen per cent of the volume produced was beech, a species that contributed nothing to stumpage value and was, in fact, a silvicultural problem on the Forest.

Actually the cut followed closely the species proportions found on the Forest before cutting (see Table 1).

It might be argued that more of the cut should have come from the less desirable species. However, the demands of the market, the costs of the logging operations, and the condition of the stands made it difficult to run a self supporting operation in a silviculturally more satisfying manner.

SALES AND MANUFACTURING PROCEDURES

Sales Objectives and Policies

An understanding of the manufacturing procedures used on the forest should be aided by a consideration of the sales objective and sales policies that guided the entire operation. Simply stated, the sales objective was to extract the highest value possible from sales of lumber on the general market.

To achieve this objective a policy of careful manufacturing, seasoning, and sorting by species and grades was pursued in an effort to build up a high value end product in marketable quantities. Mill run sales of green lumber were strictly discouraged.

Hard maple provides a good example of the utilization procedure. This species was found scattered throughout the Forest and accounted for only five per cent of the total volume cut, and no large amount of it was manufactured at any one time. Mill run sales would have forced its inclusion with general run of species being manufactured at the moment and it might have sold for $60 per M B.F. However, by careful manufacture and accumulation of this species, and by grading and air drying, it was possible to sell the top grades for over $200 per M B.F.

A special feature of the utilization program was the necessity of pro-

TABLE 6

Volume Cut, Tree Estimate, by Species Group and Logging Unit on the Island Creek Experimental Forest

Species Group	Rank	Paw Paw M B.F.	Laurel M B.F.	Panther M B.F.	Ashcamp M B.F.	Right Fork M B.F.	Forest M B.F.	Per Cent of Cut
Basswood	6	91	17	94	84	192	478	5
Beech	2	222	92	465	178	705	1,662	19
Gum, black	7		28	112	75	246	461	5
Hemlock and pine	10	71	1	19	67	103	261	3
Hickory	4		59	178	138	372	747	9
Maple, hard	5	90	24	143	80	155	492	6
Oaks	1	387	121	416	411	1,472	2,807	33
Other hard. (inc. hickory)*	9	306					306	4
Other hard. (exc. hickory)*	8		19	87	58	178	342	4
Yellow-Poplar and cucumber	3	147	76	168	148	511	1,050	12
TOTALS		1,314	437	1,682	1,239	3,934	8,606	100
Per Cent of cut		15	5	20	14	46	100	

* Hickory was tallied with other hardwoods in the Paw Paw unit only. In all other units hickory was separately tallied.

viding the Island Creek Coal Company with mine materials. Not unnaturally, the Coal Company expected their orders to be filled promptly. Orders for mine materials were commonly received at the mill early each week and were a priority obligation. As a result, material that might have been manufactured for sale on the lumber market was, of necessity, sometimes diverted to mine timber use.

While the need to supply mine timbers undoubtedly cut down the amount of marketable sawtimber produced from the Forest, it also had its compensations. In the first place, the entire project was made possible by the willingness of the Coal Company to engage in new procedures which might provide certain benefits. One of them, received by the Coal Company, was quick service on sudden and specialized mine timber requirements. On the other hand, the sawmill was assured of regular and substantial mine timber orders. This enabled the milling operation to get underway and to persist during the period while a place in the lumber market was being established, a position which certainly was not secured overnight.

The result of the policies followed in the utilization of the 9,861 M B.F., lumber tally, produced from the Forest was that 28 per cent of the volume appeared as market lumber, and 72 per cent as mine materials; all of the latter was used by the Coal Company.

Manufacturing Procedures

The original sawmill for the Experimental Forest was located at the North end of compartment 2 in the Laurel logging unit. It consisted of a Frick No. 1 circular mill powered by a 150 horsepower General Motors diesel engine which also ran a sawdust blower, a log turner, an edger, a double end trimmer, and a cut-off saw. A separately powered mine wedge machine was also included.

After the mill was in operation a hot water boiler was installed to provide warm water for winter log washing. In 1957 a dipping tank was added to prevent sap stain on lumber cut during the summer months.

The mill moved to its second location at the southern end of the Forest in 1958 and shortly thereafter a planing machine was put in use. Also, a new 270 horsepower diesel engine was installed. Additional machinery for mine timber manufacture was added as the need arose.

At both locations great care was taken to have the mill solidly set. Large old bridge timbers were available and a close spacing of supporting timbers was used, particularly under the track. Consequently, maintenance of track alignment presented no problem and the mill cut true.

A hand operated dolly, on steel rails, ran on a raised platform from mill to lumber yard. Lumber was stacked on each side of the platform. Close to the mill an enlargement of the platform provided a mine timber dock from which mine materials could be loaded directly on trucks. All lumber stacks could be reached by truck.

In operation, logs were rolled from trucks directly onto the log deck where they were washed and then placed on the saw carriage. The sawyer, with current mine material orders in mind, then sawed as much good

lumber as possible from the log. Mine timbers were cut from that part of the log not suitable for saw-timber.

At the tail of the mill the mine material went to a cut-off saw and was cut into the material desired. Products were stacked on the mine timber dock for loading on trucks and delivery, green, to the Company treating plant or mine.

Market lumber was edged, trimmed, and during summer months dipped. It was then transported by dolly to the yard, where it was stacked for air drying. Before the dipping tank was installed yellow-poplar was end stacked to avoid stain. After installation this was no longer necessary. Proper stacking was an extremely important part of the operation. It was done by commercial species and grades and in this manner high value lumber was accumulated in sufficient quantities to permit effective sales. In fact, in this enterprise the entire conversion return was provided by the sales income from market lumber. The importance of handling this output to secure its maximum sales price can hardly be over-emphasized.

Stacks were carefully built on raised wood foundations, stickers were properly placed and abundantly used, and the piles were covered. After two to three months the lumber was ready for sale, air dried, and at a price estimated to be about $10 more per M B.F. than if in a green condition.

SALES AND MANUFACTURING RESULTS

Production and Sales

The results, for the Forest, of the production and sales procedures described is shown in Table 7 and in more detail in Appendix Table 3. It should be noted that while market lumber amounted to only 28 per cent of the volume produced, it accounted for 44 per cent of the total sales income of $550,172. The disproportion is even more marked when high grade lumber alone is considered, the latter being 16 per cent of the volume but providing almost a third, 32 per cent, of the sales income. The average value of all market lumber was $88.17 per M B.F., which is just about twice the unit value of mine materials.

The lumber prices used in computing values were F.O.B. prices at the mill, while mine timber prices were those received on delivery to a mine or to the Company's treating plant. Delivery to the Company cost

TABLE 7

Volume and Sales Value of Lumber Tally Production by Product, Island Creek Experimental Forest

	Volume		Dollar Value	
Product	**M B.F.**	**Per Cent**	**Per M B.F.**	**Per Cent**
High grade lumber *	1,560	16	$ 112.68	32
Low grade lumber **	1,195	12	56.17	12
Mine material	7,106	72	43.24	56
FOREST TOTAL	9,861	100	$ 55.79	100

* No. 1 common and better. ** No. 2 common and poorer.

an average of $6.15 per M B.F. for the entire operation which would represent an average at the mill sales price per M B.F. of $37.09. Actually, the mill sales value of mine timbers varied from about $34 to $38, and in every logging unit was less than the logging and milling costs which averaged $38.31 per M B.F.

Simply put, the sales income from mine materials failed by about $1.25 per M B.F. to meet the operating costs of this product. In addition the sales contributed nothing to profit margin or stumpage for the Forest operation.

None-the-less the production of mine timbers was a necessary part of the Forest project. Mine materials carried most of their operating costs and thereby lessened these charges on the more valuable products. Furthermore, it was estimated by the resident forester that the prices paid by the Company for mine timbers was about $2.50 per M B.F. less than those charged by completely independent suppliers of mine materials. If this is true, then the mine timber part of the operation actually could have produced a small conversion return and could have been carried out without causing any out-of-pocket loss to the mill operator from the production of this product.

It is quite evident from the data presented that the source of profit in operating forests of this sort lies in the sale of lumber rather than mine timbers. It should be almost as plain that the possibility of at least a break-even sale of mine timbers is essential, at least in-so-far as the effective utilization of much low-quality raw material is concerned.

Manufacturing Costs

Sales, mill production, and cost reports were not kept in an entirely satisfactory form prior to 1960. While desired information was on record, the milling costs, in particular, were difficult to isolate in a readily useable manner. This led to apparent inconsistencies which, while statistically insignficant, were annoying.

Starting in 1960 an accounting system designed by a Coal Company accountant in consultation with the resident forester was adopted and subsequent records were more easily used. Also, in 1960 the operation was running smoothly in the Ashcamp and Right Fork units and the costs were probably a good sample of the woods and mill operations at their most efficient level. Table 8 presents certain production and cost data recorded for the calendar year 1960.

For the operation as a whole, the records show that total costs of $377,811 were incurred in the logging and manufacture of 9,861 M B.F. of products, or an average cost per M B.F. of $38.31, which is slightly higher than the $37.83 shown for the year 1960. By logging units, the production costs ranged from $35.86 in the Paw Paw unit to $46.62 in the Laurel unit, all on a per M B.F. lumber tally basis. Operating costs in the Laurel unit were exceptionally high both because of the light scattered timber on difficult terrain and because of operational problems at the mill.

Stumpage Values

Prior to the operation of the Experimental Forest it had been the custom of the Island Creek Coal Company to allow selected private mine

timber contractors to cut timber from the Company's forests and deliver mine materials to the Company treating plant or to the mines. The timber operator was charged no stumpage fee and the standing timber values were reflected only in the somewhat lower than general market price paid the operators for the material so secured. It was, in consequence, virtually impossible to make any convincing statement about the stumpage values.

While the distribution of the conversion return, or sales returns minus operating costs, between owner and operator on the Experimental Forest was arranged in a somewhat unorthodox manner, it did recognize the existence of stumpage values by providing that the Company should receive a percentage of the gross sales price of all lumber, excluding mine materials, sold from the mill. Until July 1960 the figure was 15 per cent, after which it was raised somewhat. Actually, by this arrangement, the Company return was assured whatever the operating costs turned out to be. It was the mill operator who took the greater risk of loss. It should be noted, however, that as the operation progressed the Company occasionally advanced capital against a lien on the lumber stored in the yard, so it did not completely avoid the assumption of risk.

In an effort to show standing timber values in a more conventional manner, appraisals were made by each logging unit, using a selling value ratio procedure with the following components:

R = Sales returns

C = Operating Costs including depreciation

M = Margin for profit and risk

S = Stumpage value

$O = (C + S)/R$ = The Operating Ratio, or the percentage of sales income required to cover C and S

$Q = 1 - O = M/R$ = The Selling Value Ratio, or the percentage of sales income required to provide a margin for profit and risk.

The basic relation is $S = R - C - M$, and $R - C$ is the conversion return.

With an operating ratio determined on the basis of what similar, and satisfactorily operating, enterprises are showing, and by noting the $M=QR$, and with C available, S results from the solution of the basic equation. This is the usual solution used as a basis for stumpage sales in advance of the actual cutting operation.

On the Experimental Forest R and C were known. In addition, total S was available from the record of the lumber sales and the agreed on percentage thereof paid to the Company. Note, also, that all stumpage payments came from the sale of lumber; mine materials were excluded.

Under the forementioned conditions it was thought that it would be instructive to use the R, C, and S available and to determine M and the operating ratio (O) that actually prevailed. This ratio could then be compared with that of the Coal Company in its usual line of business, which in 1960, and before Federal Income taxes, appeared to be something over 95 per cent. For the entire Experimental Forest operation the mean ratio was a little over 82 per cent.

Table 9 shows the gross dollar data from which the individual logging unit appraisals were made.

In Table 9 the total sales income, $506,475, will not agree with the total obtained as the product of the average selling price per M B.F., $55.79, and total production, 9,861 M B.F., shown in Table 7. This latter amount is $550,172 and the difference arises from the fact that in computing average sales value mine timbers were included at their point of delivery price of $43.24, while in the stumpage value computations mine timbers were valued at $37.09 per M B.F., their F.O.B. mill price.

As stumpage values are ordinarily computed on the F.O.B. mill basis, the use of mill prices was the preferable procedure. Also, as all stumpage value derived from the sale of lumber only, this adjustment had no effect on the total stumpage value.

The high overrun in the Paw Paw, Laurel, and Panther units can only be explained as inexperience in the application of the tree net volume

TABLE 8

Production and Production Costs for the Calendar Year, 1960.
Island Creek Experimental Forest

Item	Amount
Production, Lumber Tally	
Market lumber, 33 per cent	690 M B.F.
Mine material, 67 per cent	1,405 M B.F.
Total 100 per cent	2,095 M B.F.
Production costs, lumber tally *	
Felling	$ 2.83 per M B.F.
Skidding	12.85 per M B.F.
Truck to mill	7.69 per M B.F.
Sawing	12.20 per M B.F.
Stacking and loading	2.26 per M B.F.
TOTAL	$37.83 per M B.F.

* Includes appropriate maintenance, depreciation, business taxes, licenses, and insurance.

TABLE 9

Appraisal Data by Logging Units on the Island Creek Experimental Forest

Item	Paw Paw	Laurel	Panther	Ashcamp	Right Fork	Forest
Overrun per cent	29.4	23.8	23.7	7.1	7.1	14.6
R (sales returns)	$74,583	$26,600	$102,287	$73,723	$229,282	$506,475
C (operating costs)	60,956	25,207	83,729	49,830	158,089	377,811
M (profit margin)	8,128	-346	11,867	17,818	51,597	89,424
S (stumpage value)	5,499	1,739	6,691	6,075	19,236	39,240
S (per M B.F., t.e.)	$4.18	$3.98	$3.98	$4.90	$4.89	$4.56
Operating ratio	.8910	1.013	.8840	.7583	.7734	.8234

tables used. The Ashcamp and Right Fork overrun of 7.1 per cent is a much more expected value.

The data for the Laurel unit invites special attention. Here the conversion return, R - C, while positive, was not sufficiently great to cover both stumpage and the desired profit margin. In fact, the operating ratio was greater than unity and the selling value ratio negative. By the time the operator had paid his stumpage assessment and operating costs he was $346 in the red. This is the only unit in which this unfortunate result occurred. The physical reasons that contributed to this loss have already been mentioned.

The Ashcamp and Right Fork units represent the operation at its best. Accounting for 56 per cent of the volume manufactured and 59 per cent of the total sales value, these units were operated with maximum efficiency. Not only were logging costs low but the mill had all of its special machinery and the result was reflected in a smoothly run operation producing maximum stumpage values.

The last column in Table 9 shows the performance for the entire forest. The over-all figures also show that while an operator might have been financially hurt in the Laurel unit, had he persisted throughout the entire operation he would have come out in the black.

The average stumpage value per M B.F. (tree estimates) was not high, only $4.56. However, it must be remembered that this value applies to both lumber and mine material.

Table 10 shows stumpage value differences between species.

Reference to Table 10 shows at once the relative species values. Basswood, hard maple, yellow-poplar, and cucumber produced 80 per cent of the positive stumpage value, although they accounted for only 23 per cent of the tree volume cut. Oaks, because of their abundance, also provided substantial stumpage income. Hemlock, commonly not considered particularly valuable, exhibited the fourth highest stumpage price. There was an interesting explanation for this. Hemlock was totally unacceptable for mine materials so it was all sold for lumber and consequently had a higher average sales price than would have been the case if a large part of it had been used for mine timbers. This tends to support the opinion, already ventured, that a higher output of market lumber would have substantially increased the stumpage value.

Beech, blackgum, and hickory all produced negative stumpage values. This is regrettable, and need not always be the case, but it was true in this operation. At best they were low value species and their removal from the forest was desirable from a silvicultural and management viewpoint. The consolation is that the better species were able to carry them and still produce a positive stumpage value for the entire operation.

So far as the Coal Company was concerned, it received as stumpage payments some $39,000. However, if one accepts $2.50 per M B.F., lumber tally, as the difference between its payment for delivered mine material and the general market price quoted by non-company connected suppliers the Company, in effect, received an additional stumpage payment of

$18,000, for a total stumpage income of $57,000. The possibility of such a return, while at the same time improving the forest, is one of the main points that this project sought to demonstrate.

OPERATIONAL CONTROL ON THE FOREST

Some consideration of the way in which operations were effected on the Forest may be helpful to those interested in this subject, for it is evident that such operations do not just happen.

The employment of a resident forester has already been mentioned, and it was this man who represented the University and had direct supervision of all operations.

It should be emphasized at the start that the Island Creek Coal Company was never directly engaged in the business of logging, milling, and product sales.

The key man on the ground was the contractor, who worked under the general supervision of the forester. It was the contractor, that as an independent operator, conducted the logging, milling, and sales phases of the project. He also kept the records necessary to facilitate a description of the work done.

Knowledge of the lumber market and sales ability were qualities much needed by the contractor, especially in the early years of the operation when a place in the market was being established. A thorough knowledge of the logging and milling business and a willingness to accept the philosophy of the project and to try new procedures was required. Financial responsibility and resources were also needed.

The services of the contractor were secured by means of a three-way agreement between the contractor, the Coal Company, and West Virginia University. To illustrate their exact relation to the project a copy of the 1960 contract is included in the Appendix.

OTHER OPERATIONS ON THE FOREST

Cull Elimination

A troublesome, but common, component of the forest stands was the nonmerchantable, or cull, tree. Such trees, chiefly beech, were not included in the tree estimate of sound volume, yet on the Forest they were present at an average rate of 2.28 trees per acre. On the Paw Paw unit, for example, 93 per cent of the culls were beech, and culls in this unit averaged nearly 18 inches in d.b.h.

Had the only object of the woods operations been the removal of merchantable volume these culls could have been left. However, as subsequent development of thrifty forest stands was a principal aim, leaving the culls, especially in view of their large size would have jeopardized the satisfactory development of the residual stands.

Since loggers dislike felling culls, particularly when they are paid on a sound volume produced basis, it was decided to eliminate the culls with herbicides and this method was used in the Paw Paw, Laurel, and Panther units. In the Paw Paw unit this was done after the logging operation. Subsequently it seemed that costs might be reduced if it was done

TABLE 10

Stumpage Values per M B.F., Tree Estimate, by Species Groups and Logging Units on the Island Creek Experimental Forest

Species Group	Stumpage Value per Thousand Board Feet						
	Paw Paw	Laurel	Panther	Ashcamp	Right Fork	Forest	Per Cent Pos. Value
Basswood	$ 10.87	$ 15.91	$ 14.35	$ 24.04	$ 25.26	$ 19.83	19
Beech	-3.18	.78	1.26	-1.70	- .94	- .61	-
Gum, black		-11.60	-9.57	-9.22	-8.60	-9.12	-
Hemlock and pine	11.82	12.60	11.55	8.33	9.31	9.92	5
Hickory		-11.60	-9.57	-9.22	-8.60	-9.18	-
Haple, hard	20.47	28.65	25.41	22.29	23.54	23.57	23
Oaks	3.06	1.72	2.03	1.73	2.58	2.40	13
Other hard. (inc. hickory)	.26					.26	negl.
Other hard. (exc. hickory)		-4.96	-3.79	6.20	7.10	3.51	2
Yellow-poplar and cucumber	8.61	20.89	18.72	19.66	20.86	18.64	38
ALL SPECIES	$ 4.18	$ 3.98	$ 3.98	$ 4.90	$ 4.89	$ 4.56	100

before logging, but on trial this did not prove to be the case. After logging debris was not dense enough to impede travel, and the identification of culls was simple and complete. The herbicide used in the Paw Paw and Laurel units and in compartments 1-6 of the Panther unit was two pounds acid by weight of 2,4,5-T ester in a water carrier. In compartments 7, 8, 9 of the Panther unit and in compartments 1 and 2 of the Right Fork unit diesel fuel replaced the water carrier in an effort to improve the penetration of the agent. While water was generally available it had been observed that many trees resisted death for several years after treatment, and it was hoped that the use of diesel fuel would prove more effective.

Cull treatment was carried out by two- or three-man crews. Trees were completely frilled with an axe at a convenient height during the active growing season. Herbicide was then poured into each frill all around the bole. Every effort was made to leave no cambial continuities when frilling. The average cost per tree for this method was 53 cents for 4,662 trees.

By 1958, when operations were underway in the Right Fork unit, herbicides were abandoned and cutting the culls adopted as the working procedure. This was made possible by the fact that the woods crew had become used to Experimental Forest procedures and could be depended on to cut the designated culls. As these were identified and marked when the forest inventory was taken the woods crew felled and left them as they carried on the logging. For this they were paid 25 cents per tree and this procedure proved to be the best method of handling the cull tree problem. Table 11 presents a summary of the cull elimination program on the Island Creek Experimental Forest.

Erosion Control

Horse skidding from stump to landing was used throughout the entire Experimental Forest operation and most of it was done as directly

TABLE 11

Cull Elimination by Method Used and Logging Unit

Unit	Method	No. of Trees	Volume M B.F.	Cost per Tree (Cents)
Paw Paw	Herbicide	1,200	240	40
Laurel	Herbicide	1,951	593	49
Panther	Herbicide	1,217	309	69
Right Fork (1, 2)*	Herbicide	294	88	62
Right Fork (3-8) **	Cutting	522	156	25
Ashcamp	Cutting	313	95	25
TOTAL		5,497	1,481	49
TOTAL TREATED WITH HERBICIDE		4,662	1,230	53
TOTAL CUT		835	251	25

* Compartments 1 and 2

** Compartments 3-8

downhill as possible. Trees were bucked into logs at their points of felling and, using grab hook trailers, were assembled into trains of up to five logs which were then dragged downhill to the landings. With grades as steep as those locally encountered there was an inherent danger of run-a-ways with this procedure; however, the teamsters were sufficiently skilled so that no serious accidents of this nature occurred and the steep topography assisted, rather than hindered, the skidding operations.

From the standpoint of site protection there is a generally held aversion to the method of skidding used because of the likelihood of creating erosion channels after logging. Within a year such channels can erode into steep-sided gullies and in the process deposit a large amount of soil and detritus in the valley bottom streams. A heavily-used skidding trail has an inherent head start on this sequence, and as heavy cuts per acre favor heavy trail use, clear cutting methods have come to be associated with severe gully erosion, in consequence of which clear cutting methods have often been condemned as destructive of the forest site.

The erosion damage described has not been found to be an inevitable result of downhill horse skidding on the Experimental Forest. By employing a two- or three-man crew to go over each compartment after logging, erosion damage has been minimized. The control consisted of placing stones and brush in the skid trails and the construction of diversion ditches and water bars at critical points. Closed out skid trails were observed for at least a year after treatment and additional follow-up work was done where needed. The result has been that within two years after logging good conditions prevailed on all compartments and no serious gullies were developed.

Costs for closing skidding trails averaged 60 cents per acre cut for the forest and ranged from a low of 40 cents up to 84 cents.

Reproduction Study

In order to observe the development of tree reproduction after cutting, transect lines were laid out in the seed-tree (1, 3, 10) and shelterwood (2, 6, 12) compartments in the Paw Paw unit. These lines, shown on the Forest map, Figure 1, ran up the slopes and along them permanent milacre plots were established so as to secure 30 to 40 plots in each compartment. Plot spacing varied from compartment to compartment but was never less than one chain. Tree reproduction by height class was recorded in 1955 and again in 1959.

Table 12 shows, by species groups, the reproduction count in 1955 and 1959 together with the change in numbers over the four-year period.

If basswood, hemlock, pine, hard maple, oaks, and yellow-poplar are considered the desirable species, then they held their own in relative amounts, accounting for 36 per cent of the total numbers in both years. Worth noting is the high reduction in yellow-poplar, 55 per cent, at the end of the four-year period. This suggests the desirability of cleanings at an early age in order to assure the continuation of this valuable species, particularly in the seed tree areas.

Except for compartment 1 in the Ashcamp unit, the transect method

of observing reproduction was not established in the other logging units. It was slow and expensive and other means were adopted to secure the desired information on stand reproduction.

Silvicultural Study Plots

Although initial cutting on the Forest was determined by compartment appearance and the tree tally, more detailed information was desired to properly appraise the response to cutting and to formulate future development plans. For this purpose a series of silvicultural study plots, one to be established at the approximate geometric center of each compartment, was planned. During 1962, 1963, and 1964, 18 such plots were actually installed, 12 in the Paw Paw unit, three in the Laurel unit (8, 9, 10), and three in the Panther unit (1, 2, 3).

Each plot was one-half acre in size, with the long dimension oriented to the north. Four milacre reproduction plots were placed on a line bisecting the half-acre plot along its long dimension.

On each plot all trees 7.6 inches d.b.h. and up were numbered and tallied by species, diameter, crown class, and number of 16-foot logs to the nearest half-log. In addition, for about a dozen trees information was taken on stump diameter, height to live crown, total height, and crown diameter. Trees 0.6-7.5 inches in d.b.h. on half the main plot were tallied by species, and for a number of these trees total heights were measured in order to facilitate the preparation of a height curve for this class.

All of the silvicultural study plots are to be treated in the same manner as the compartment in which they lie, and they are intended to provide an indication of the compartment response to treatment in a manner more detailed than can be expected from the tree inventory alone.

As none of the silvicultural study plots have, as yet, been remeasured,

TABLE 12

Reproduction Count After Logging on the Paw Paw Seed Tree (1, 3, 10) and Shelterwood (2, 6, 12) Compartments — 197 Milacre Plots Converted to a Per Acre Basis

Species Group	Reproduction Count Per Acre		Per Cent Change
	1955	1959	
Basswood	162	178	+10
Beech	2,107	1,254	-40
Gum, black	1,188	690	-42
Hemlock and pine	41	51	+24
Hickory	1,492	1,249	-16
Hard maple	1,939	1,645	-15
Oaks	3,157	2,025	-36
Other hardwoods	3,518	2,315	-34
Sassafras	3,817	2,604	-32
Yellow-poplar	1,650	746	-55
TOTAL PER ACRE	19,071	12,757	-33

no comparisons are currently available. None-the-less such plots should provide important information on future stand development.

Roads and Fire Trails

In general, logging roads constructed for the first round of cuttings on the Experimental Forest ran alongside, or in, the creeks leading into the units. Advantage was taken of old road locations. Construction consisted of bulldozing boulders from the creek bottoms, and the minimum possible touch-up work on the old roads. In the Paw Paw unit, for example, approximately $300 was spent in establishing a mile and a half of logging road, much of which was located in the hard-bottomed Paw Paw Creek.

Roads of the sort just described are commonly used in local timber cutting operations, but they should be recognized as temporary expedients, serving only for the immediate removal of timber. In fact, that part of the Paw Paw road located in the creek bottom was impassable within a year after the conclusion of the first cutting operation.

A forest handled on a sustained production basis should have a permanent road system, useable the year around, in order to facilitate maintenance, applied silviculture, and the easy removal of products. Such a road system was planned for the Experimental Forest, although it was not established immediately.

In 1964 a mile and a half of permanent logging road was constructed into the Paw Paw unit. With no adverse grade exceeding 10 per cent, the road was wide, well drained, and located entirely out of the creek bottoms. The projected location of this road, now substantially completed, can be seen on the map of the Forest (Figure 1). Built almost entirely with a large Caterpillar bulldozer, the actual bulldozing time was 27 hours per mile. The cost, with culverts, was $533 per mile. This was not considered expensive. In fact, such roads might well cost $1,000 per mile.

Even at the time the creek bottom roads were being used for the first logging operations it was recognized that roads or trails giving general access to the forest would be helpful in forest administration and in fire protection. The layout of the system finally developed can be seen on the Forest map (Figure 1).

Such truck fire trails are located on the ridge tops, can be traveled by four-wheel drive, or pickup trucks and provide a means of getting working or fire crews to any part of the forest. They also serve as ridge top fire breaks.

The first of the truck fire trails was established in 1952. Entering the Forest through compartment 4 in the Laurel unit, it ascended to the ridge top and extended almost completely around the Paw Paw unit. Construction consisted of bulldozing a right-of-way and a minimum amount of drainage improvements. A little over three miles of trail was built. Unfortunately, good cost records were not kept.

In 1956, an additional 3.25 miles of truck trail were built between the Panther and Right Fork units and down through the Right Fork unit to the Forest boundry. Costs for this road ran about $258 per mile.

In 1964, another three miles of truck trail cost $239 per mile.

Costs for the truck fire trails cover only the basic construction, and are not too exact. It does appear, however, that for $250 to $300 per mile such truck trails can be established by using a bulldozer as the basic construction tool.

Fire Control

Information prepared for a Fire Prevention Conference held at Williamson, Mingo County, in 1959, showed that for the 10-year period, 1948-1957, the County suffered a yearly average of 98 fires burning 16,841 acres, or 6.2 per cent of the total land area, and doing yearly damage estimated at $77,000. This established Mingo County as one of the State's worst fire areas. It was obvious to the Experimental Forest managers that any program of continuous forest production in the County could hardly hope to be successful unless effective fire control could be established.

In an effort to prevent, or at least minimize, forest fire loss, several steps were taken which, collectively, seemed to work well in reducing fire loss on the Experimental Forest. An immediate and continuing effort was undertaken to secure the cooperation and good will of the local population. The purpose of the Experimental Forest was explained to key men residing near the Forest and their support was solicited. Local men were hired for development work on the Forest, and when cutting operations started in 1953, many more found employment on the logging or milling crews and so acquired a stake in the continued welfare of the Forest.

A second effort was concerned with insuring the availability of capable fire crews. Working with local fire wardens and Company personnel, plans were made in advance for the men and equipment needed to cope with fires.

A third step was the construction of truck fire trails along the ridge tops on the Forest, a physical improvement already described.

It appears that these efforts achieved some success, as indicated by the fire record on the Experimental Forest, shown in Table 13.

Inspection of Table 13 shows that the average yearly fire loss on the Forest was 22.6 acres, or seven tenths of one per cent, considerably

TABLE 13

Recorded Fires on the Experimental Forest, 1952-1961

Year	Month	Acres Burned
1952	October	74
1952	December	25
1953	October	102
1957	July	14
1957	July	11
Total (5 fires)		226

better than the 6.2 per cent figure previously quoted for the county. It is believed that at least a part of the superior fire record on the Experimental Forest was due to the fire control measures adopted.

An important outgrowth of the fire experiences during the above period was the formulation of a cooperative fire control plan by the Coal Company and the Conservation Commission of West Virginia. Starting in April 1961, the plan provided for the duties and responsibilities of the two contracting parties in maintaining effective fire control on all of the Company's lands.

Summary of Accomplishments

In retrospect, how successful were the operations on the Island Creek Experimental Forest during the years 1952 through 1961 in demonstrating the feasibility of forest management in southern West Virginia forests? This question can best be answered by considering three aspects of the venture.

From an economic standpoint, it was demonstrated that the lumber produced in a combined mine-timber and commercial lumber operation could find favorable place in the market if it was carefully manufactured, seasoned, graded, sorted and kept available for quick delivery in at least semi-trailer lots of around 7,000 board feet. Once aggressive salesmanship of lumber had created some satisfied customers, no real difficulty was experienced in subsequent lumber marketing.

From a business standpoint, the 10-year results were permissive for such operations, rather than highly profitable. The total conversion return amounted to $128,664 over the period, and of this the Coal Company received $39,240 in the form of stumpage payments. In addition, they received, in effect, an additional $18,000 by buying the mine timbers at less than the open market price. This total of $57,240 represented net income to the Company and, while not large, would have more than defrayed the expenses incurred by the Company on all the forest improvements not already included in the logging and milling costs, such as fire trails and the 1964 permanent logging road.

All of the forementioned income was derived from cutting on the 2,420 operable acres of the 3,188 acre Experimental Forest, and it came from run-down stands averaging only 4,500 board feet per acre at the start of operations. At the conclusion of cutting, only about 1,000 board feet per acre was left but the condition of the stands for future growth had been improved.

The financial point to be made is that areas such as the Experimental Forest can be operated so as to pay their own way and to improve production. This should be encouraging to forest owners who are somewhat hesitant about embarking on forest management programs.

Finally, there is the technical aspect of the experimental venture. A ground-work was laid for a future comparative evaluation of stand pro-

duction methods. It is hoped that this non-spectacular, but important, phase of the forestry program will be followed up effectively.

Logging and milling equipment and procedures used were generally available and understandable. Improvements were made as the need was felt and opportunity permitted. The effect was to check out procedures that the average industrial owner could easily emulate. Working on this basis did not jeopardize the financial soundness of the work.

Finally, it should be emphasized that no starting innovations or miraculous procedures were devised or used on the Island Creek Experimental Forest. What was demonstrated over the 10-year period was that forestry is feasible today on similar areas by the careful application of extant forestry knowledge. This is perhaps the most important contribution the project can make to the potential, but hesitant, forest owner-operator.

THE EXPERIMENTAL FOREST AFTER 1961

In 1960, after nine years of Experimental Forest operation, and with the original 10 year agreement due to expire in 1961, a meeting was held with Coal Company personnel for the purpose of reviewing the work accomplished and considering future plans. The result was a new agreement, effective July 1, 1960, and extending the Experimental Forest arrangement for 10 years. John Bell was made Company, as well as Experiment Station forester and the Company undertook to pay a substantial part of his salary.

The following year, 1961, the first round of cutting was completed on the Experimental Forest and cutting operations, based on the experience accumulated over the 10-year period, were extended to additional Company lands, under the direction of Bell and his assistant, Joseph Wolf, in their capacities as Company foresters. It appeared that a going forest enterprise had been successfully launched by the Coal Company.

In 1965, however, after the reorganization of the Island Creek Coal Company, the new management decided to dispose of their surface holdings and to confine themselves strictly to the coal business. Exercising their right to terminate the Experimental Forest agreement, they then sold their surface rights to the Georgia-Pacific Corporation.

Fortunately, in 1966, an agreement was made with the new owners that provided for the continuation of the Experimental Forest, although under somewhat altered circumstances. It now appears that it may be possible to continue the comparison of the silvicultural production methods so painstakingly established.

REFERENCES

Brooks, A. B. 1911. Forestry and Wood Industries. West Virginia Geological Survey. 481 pp., illus.

Ferguson, R. H. 1964. The Timber Resources of West Virginia, Northeastern Forest Exp. Sta. U.S.F.S. Resource Bull. NE-2. 123 pp., illus.

Hagenstein, P. H. 1964. Timber Industry Opportunities in Selected Areas of West Virginia. Northeastern Forest Exp. Sta. U.S.F.S. Research Paper NE-28. 72 pp.

Hennen, R. V. and Reger, D. B. 1915. Logan and Mingo Counties. West Virginia Geological Survey, County Reports for 1914. 776 pp., illus.

Island Creek Coal Company. 1962. Annual Report — 1961. 13 pp.

Island Creek Coal Company. 1965. Annual Report—1964. 13 pp.

Mesavage, C. and J. W. Girard. 1946. Tables for Estimating Board Foot Volume of Timber. U.S.F.S. Publication. 94 pp.

Mingo County Forest Fire Prevention Conference. 1959. Program. 4 pp.

Society of American Foresters. 1958. Third ed. 97 pp.

Society of American Foresters. 1964. Forest Cover Types of North America. 67 pp.

Thompson, J. H. 1964. The Changing Markets for West Virginia Coal 1951 - 1963. West Virginia University Business and Economic Studies. 40 pp.

United States Department of Agriculture. 1941. Climate and Man—Yearbook of Agriculture. 1,248 pp., illus.

West Virginia Department of Mines. 1965. Annual Report — 1964. 249 pp.

APPENDIX TABLE 1

Areas, Volumes, and Logging Costs to Truck Roads by Logging Unit and Compartment
Island Creek Experimental Forest, 1954-61

Unit	Comp.	Silv. Method	Acres Cut	Tree Estimate			Vol. Cut Per Acre (M B. F.)	Per Cent Vol. Cut (M B. F.)	Felling and Skidding Costs	
				Net. Vol. (M B. F.)	Vol. Cut (M B. F.)	Vol. Left (M B. F.)			Per M B.F.	Per Acre
Paw Paw										
	1	S.T.	57	353	256	97	4.5	72	$14.12	$63.41
	2	SH.	57	209	159	50	2.8	76	19.95	55.65
	3	S.T.	72	324	238	86	3.3	73	27.60	91.22
	4	S-20	39	103	54	49	1.4	52	36.68	50.79
	5	S-10	40	61	21	40	0.5	34	43.05	22.60
	6	SH	23	101	79	22	3.4	78	12.30	42.26
	7	S-10	31	164	83	81	2.7	51	23.04	61.68
	8	S-20	78	254	160	94	2.0	63	21.89	44.91
	9	S-10	45	152	90	62	2.0	59	24.60	49.20
	10	S.T.	26	76	42	34	1.6	55	27.64	44.65
	11	S-20	46	146	55	91	1.2	38	21.94	26.23
	12	SH.	34	111	77	34	2.3	69	9.66	21.88
		TOTAL	548	2,054	1,314	740	2.4	64	$21.27	$51.01
Laurel										
	8	S-10	79	191	156	35	2.0	82	$36.79	$73.60
	9	S.T.	21	72	64	8	3.0	89	30.44	97.40
	10	S-20	91	251	217	34	2.4	86	26.80	64.62
		TOTAL	191	514	437	77	2.3	85	$30.90	$71.83

Panther										
	1	S-20	143	267	239	28	1.7	90	$30.46	$50.91
	2	SH.	60	189	159	30	2.6	84	26.95	70.26
	3	S.T.	83	404	351	53	4.2	87	31.47	133.08
	4	S-10	63	261	219	42	3.5	84	20.31	72.91
	5	SH.	36	140	110	30	3.0	78	20.49	62.61
	6	S.T.	70	400	341	59	4.9	85	23.65	115.19
	7	S-10	57	258	200	58	3.5	78	20.81	73.01
	8	S-20	26	78	55	23	2.1	70	32.31	68.34
	9	SH.	1	11	8	3	8.0	73	12.43	99.43
		TOTAL	539	2,008	1,682	326	3.1	84	$25.81	$80.69
Ash Camp										
	1	S.T.	135	925	774	151	5.7	84	$16.05	$92.02
	2	S-20	63	262	216	46	3.4	82	21.29	72.99
	3	SH.	74	348	249	99	3.4	72	18.18	60.35
		TOTAL	272	1,535	1,239	296	4.6	81	$17.39	$78.92
Right Fork										
	1	S.T.	109	871	753	118	6.9	86	$17.10	$117.02
	2	S.T.	125	690	592	98	4.7	86	17.28	81.85
	3	S-20	106	558	462	96	4.4	83	17.00	74.08
	4	S-20	90	659	569	90	6.3	86	16.00	101.13
	5	SH.	120	516	385	131	3.2	75	16.61	53.73
	6	S-10	120	565	445	120	3.7	79	14.09	53.15
	7	S-10	102	454	351	103	3.4	77	19.06	67.58
	8	SH.	98	448	377	71	3.8	84	18.03	70.08
		TOTAL	870	4,761	3,934	827	4.5	83	$16.83	$76.63
TOTAL FOREST			2,420	10,872	8,606	2,266	3.6	79	$20.06	$71.33

APPENDIX TABLE 2

Areas, Volumes, and Logging Costs to Truck Roads by Silvicultural Method and Compartment
Island Creek Experimental Forest, 1954-61

Method	Unit	Comp.	Acres Cut	Tree Estimate			Vol. Cut Per Acre (M B.F.)	Per Cent Vol. Cut (M B.F.)	Felling and Skidding Costs	
				Net Vol. (M B.F.)	Vol. Cut (M B.F.)	Vol. Left (M B.F.)			Per M B.F.	Per Acre
S.T.	P.P.	1	57	353	256	97	4.5	72	$14.12	$63.41
	P.P.	3	72	324	238	86	3.3	73	27.60	91.22
	P.P.	10	26	76	42	34	1.6	55	27.64	44.65
	L	9	21	72	64	8	3.0	89	30.44	97.40
	P	3	83	404	351	53	4.2	84	31.47	133.08
	P	6	70	400	341	59	4.9	85	23.65	115.19
	A	1	135	925	774	151	5.7	84	16.05	92.02
	R.F.	1	109	871	753	118	6.9	86	17.10	117.02
	R.F.	2	125	690	592	98	4.7	86	17.28	81.85
		TOTAL	698	4,115 (5.9m/a)	3,411	704	4.9	83	$19.91	$97.32
SH.	P.P.	2	57	209	159	50	2.8	76	$19.95	$55.65
	P.P.	6	23	101	79	22	3.4	78	12.30	42.26
	P.P.	12	34	111	77	34	2.3	69	9.66	21.88
	P	2	60	189	159	30	2.6	84	26.95	70.26
	P	5	36	140	110	30	3.0	78	20.49	62.61
	P	9	1	11	8	3	8.0	73	12.43	99.43
	A	3	74	348	249	99	3.4	72	18.18	60.35
	R.F.	5	120	516	385	131	3.2	75	16.61	53.73
	R.F.	8	98	448	377	71	3.8	84	18.03	70.08
		TOTAL	503	2,073 (4.1m/a)	1,603	470	3.2	77	$18.24	$58.14

S-20	P.P.	4	39	103	54	49	1.4	52	$36.68	$50.79
	P.P.	8	78	254	160	94	2.0	63	21.89	44.91
	P.P.	11	46	146	55	91	1.2	38	21.94	26.23
	L	10	91	251	217	34	2.4	86	26.80	64.62
	P	1	143	267	239	28	1.7	90	30.46	50.91
	P	8	26	78	55	23	2.1	70	32.31	68.34
	A	2	63	262	216	46	3.4	82	21.29	72.99
	R.F.	3	106	558	462	96	4.4	83	17.00	74.08
	R.F.	4	90	659	569	90	6.3	86	16.00	101.13
		TOTAL	682	2,578 (3.8m/a)	2,027	551	3.0	79	$21.27	$63.22
S-10	P.P.	5	40	61	21	40	0.5	34	$43.05	$22.60
	P.P.	7	31	164	83	81	2.7	51	23.04	61.68
	P.P.	9	45	152	90	62	2.0	59	24.60	49.20
	L	8	79	191	156	35	2.0	82	36.79	73.60
	P	4	63	261	219	42	3.5	84	20.31	72.91
	P	7	57	258	200	58	3.5	78	20.81	73.01
	R.F.	6	120	565	445	120	3.7	79	14.09	53.15
	R.F.	7	102	454	351	103	3.4	77	19.06	67.58
		TOTAL	537	2,106 (3.9m/a)	1,565	541	2.9	74	$20.66	$60.22
TOTAL FOREST	(35 Comp's.)		2,420	10,872	8,606	2,266	3.6 (3.56)	79	$20.06	$71.33

APPENDIX TABLE 3

Volume and Sales Value of Lumber Tally Production by Class of Product and Logging Unit, Island Creek Experimental Forest

Unit	Graded Lumber (F.O.B. Mill)						All Lumber (F.O.B. Mill)			Mine Material Delivered to Company			All Manufacture			Per Cent	
	No. 1 Common and Better			Less than No. 1 Common													
	Amount M B.F.	Value Dollars	Val. per M Dollars	Amount M B.F.	Value Dollars	Val. per M Dollars	Amount M B.F.	Value Dollars	Val. per M Dollars	Amount M B.F.	Value Dollars	Val. per M Dollars	Amount M B.F.	Value Dollars	Val. per M Dollars	Volume	Value
Paw Paw	190	19,456	102.40	370	17,040	46.05	560	36,496	65.17	1,140	45,098	39.56	1,700	81,594	48.00	17	15
Laurel and Panther	323	38,215	118.31	321	17,940	55.89	644	56,155	87.20	1,978	85,944	43.45	2,622	142,099	54.19	27	25
Ashcamp and Right Fork	1,047	118,102	112.80	504	32,148	63.79	1,551	150,250	96.87	3,988	176,229	44.19	5,539	326,479	58.94	56	59
Forest total	1,560	175,773	112.68	1,195	67,128	56.17	2,755	242,901	88.17	7,106	307,271	43.24	9,861	550,172	55.79	100	100
Per cent volume	16			12			28			72			100				
Per cent value		32			12			44			56			100			

APPENDIX TABLE 4

Woody Plants of the Island Creek Experimental Forest
(0.6" dbh and up)

	Common Name	Scientific Name
1.	American chestnut	**Castanea dentata** (Marsh.) Borkh.
2.	Basswood	**Tilia americana** L.
3.	Beech	**Fagus grandifolia** Ehrh.
4.	Bitternut hickory	**Carya cordiformis** (Wang.) K. Koch
5.	Black birch	**Betula lenta** L.
6.	Black cherry	**Prunus serotina** Ehrh.
7.	Blackgum	**Nyssa sylvatica** Marsh.
8.	Black locust	**Robinia pseudoacacia** L.
9.	Black oak	**Quercus velutina** Lam.
10.	Buffalonut	**Pyrularia pubera** Michx.
11.	Butternut	**Juglans cinerea** L.
12.	Chestnut oak	**Quercus prinus** L.
13.	Cucumbertree	**Magnolia acuminata** L.
14.	Dogwood	**Cornus florida** L.
15.	Dwarf sumac	**Rhus copallina** L.
16.	Hazelnut	**Corylus** sp. L.
17.	Hemlock	**Tsuga canadensis** L.
18.	Hercules-club	**Aralia spinosa** L.
19.	Hickory	**Carya** sp. Nutt.
20.	Ironwood	**Carpinus caroliniana** Walt.
21.	Mulberry	**Morus rubra** L.
22.	Pawpaw	**Asimina triloba** L.
23.	Pin oak	**Quercus palustris** Muenchh.
24.	Redbud	**Cercis canadensis** L.
25.	Red maple	**Acer rubrum** L.
26.	Red oak	**Quercus rubra** L.
27.	Sassafras	**Sassafras albidum** (Nutt.) Nees
28.	Scarlet oak	**Quercus coccinea** Muenchh.
29.	Serviceberry	**Amelanchier arborea** (Michx. f) Fern.
30.	Slippery elm	**Ulmus rubra** Muhl.
31.	Sourwood	**Oxydendrum arboreum** L.
32.	Spicebush	**Lindera Benzoin** (L.) Blume
33.	Staghorn sumac	**Rhus typhina** L.
34.	Sugar maple	**Acer saccharum** Marsh.
35.	Wahoo	**Euonymus atropurpureus** Jacq.
36.	Walnut (black)	**Juglans nigra** L.
37.	White ash	**Fraxinus americana** L.
38.	White oak	**Quercus alba** L.
39.	Witch-hazel	**Hamamelis virginiana** L.
40.	Yellow-poplar	**Liriodendron tulipifera** L.
41.	Yellow birch	**Betula alleghaniensis** Britton

APPENDIX

AGREEMENT

THIS AGREEMENT, made this 1st day of July, 1960, between ISLAND CREEK COAL COMPANY, a corporation, hereinafter called the "Coal Company", the BOARD OF GOVERNORS OF THE WEST VIRGINIA UNIVERSITY, a corporation, hereinafter called the "Board", and RAYMOND CAREY, hereinafter called the "Contractor";

WHEREAS, by an instrument dated the 3rd day of October, 1951, and renewed by an instrument dated the 1st day of April, 1960, the Coal Company and the Board entered into an agreement for a program of forestry research and experimentation by the Division of Forestry of the West Virginia Agricultural Experiment Station on a tract of approximately 3,000 acres owned by the Coal Company in Mingo County, West Virginia; and

WHEREAS, the Board and the Coal Company have agreed with the Contractor for the cutting of timber from a portion of said 3,000 acre tract upon the terms and conditions hereinafter set out;

NOW, THEREFORE, THIS AGREEMENT WITNESSETH: That the parties hereto agree as follows:

1. For a period of one year from the date hereof (subject to renewal as hereinafter provided), the Contractor shall cut timber from the lands of the Coal Company lying within the boundaries of the aforesaid 3,000 acre tract and within the watershed of the Right Fork of Laurel Fork and Ashcamp Branch of the Right Fork of Laurel Fork of Pigeon Creek in Mingo County, West Virginia (estimated to contain about 1,100 acres), and shall manufacture and saw the same into the maximum amount of #2 common and better grade lumber from all species except elm, black gum, and hickory, sawing to such sizes and dimensions as will bring the maximum prices when sold on the open market; provided, however, that the Contractor shall cut and manufacture so much of such timber into mine timbers as may be ordered by the Coal Company in accordance with Paragraph 5 hereof. Such timber and/or lumber shall be cut only from such trees as are designated by the Board's forester and are marked with yellow paint, it being understood that the Board's forester shall have the full right at his sole discretion to select the trees to be cut.

2. The Contractor shall have the right to construct and install on the premises a sawmill at such location as the Coal Company or its representative may direct. As far as practicable, Contractor shall use existing roads in the performance of this agreement. If any additional roads are required, the same shall be constructed by the Contractor at his expense, subject to the prior approval of the Board's forester. Contractor shall provide all labor, tools, machinery and equipment required to perform this contract, and shall have full control of and responsibility for any workmen or agents whom he shall employ in or about such performance. The Contractor shall subscribe to the Workmen's Compensation Fund of the State of West Virginia, and shall comply in all respects with the laws and regulations of the State of West Virginia and of the United States of America relative to taxes, labor, minimum wages, maximum hours and overtime pay.

3. The Contractor shall, in the performance of this contract, conform to and abide by such directions, regulations and/or restrictions as may from time to time be prescribed by the Board's forester, including those which are attached hereto as Exhibit A. It is understood that the Contractor's operations hereunder are limited to the general purposes of and to such rights as the Board is granted under said agreement with the Coal Company dated the 1st day of April, 1960.

4. Contractor shall provide or employ for the operation of his sawmill used to saw the timber made available by this agreement a competent and reliable sawyer acceptable to the Board's forester. All lumber shall be cut to full length and shall meet the manufacture and grading requirements of the National Hardwood Lumber Association. Contractor shall furnish the Board's forester with a mill tally of all timber and lumber cut, sawed or manufactured promptly after tally of same has been made by Contractor.

5. The Contractor shall, upon the request of the Coal Company, saw and manufacture from the timber cut on the premises such mine timbers as the Coal Company may order and deliver the same to the Coal Company at such places in the vicinity of its mines as it may designate. At the time of delivery the Coal Company shall have the right to inspect, brand, measure and cord any and all timber and/or lumber furnished by the Contractor hereunder and to cull or reject any of the same which, in the Coal Company's sole judgment, is defective, sub-standard or improperly sawed. The Coal Company shall not be obligated to pay for any timbers which are culled or rejected because the same were improperly or negligently cut, sawed or manufactured by the Contractor. Any culled or rejected timbers shall be the property of the Coal Company. The Coal Company shall pay to the Contractor a sum or rate per piece or board foot as specified in the schedule of prices attached hereto and made a part hereof as Exhibit B. Such payments shall be based upon invoices furnished by the Contractor to the Coal Company at the time the mine timbers are delivered to the Coal Company, and shall be made near the 1st day of the month for all timbers delivered between the 20th and the last day of the second month passed and for all timbers delivered between the 1st and 20th of the preceding month.

6. Contractor shall pay the Coal Company as compensation for all timber cut and manufactured into lumber (not including mine timbers produced for the Coal Company under Paragraph 5 above) twenty-three percent (23%) of the gross sale price of such lumber at the mill grading #1 common or better; and shall pay fifteen percent (15%) of the gross sale price of such lumber at the mill grading #2 common or lower. Said gross sale price shall not include any compensation received by the Contractor for the transportation of the lumber from the mill site nor any taxes measured by gross receipts or gross sales and paid to the State of West Virginia. The Contractor agrees that the Board's forester shall have the right to approve or disapprove any sale or sales to the general market. The Contractor shall furnish the Coal Company and the Board's forester with a consecutively numbered copy of each invoice covering each sale of lumber at the time such lumber is delivered and shall furnish both with an invoice of the completed and agreed upon sale. Contractor shall make settlement with the Coal Company by the 8th day of each month for all lumber sold and delivered between the 1st and last day of the preceding month. All settlements shall be based on the invoices as aforesaid, regardless of whether or not the Contractor has actually received the proceeds of the same. The Coal Company shall have the right at any time to inspect any or all of the books, records, and stocks of the Contractor for the purpose of verifying such settlements. The Contractor hereby grants to the Coal Company a lien on all property placed or used by him on the premises, to secure the payment to the Coal Company of all sums which may become due hereunder.

7. The Coal Company agrees to advance the Contractor, to provide operating capital while holding the lumber until it is air dried, the sum of $50.00 per 1,000 board feet on lumber stacked on the yard for the general

market, provided that in the judgment of the Board's forester the lumber placed on the yard has an estimated market value of at least $70.00 per 1,000 board feet when sold. The maximum allowable advance under the paragraph is to be $7,000.00 on lumber at the $70.00 per 1,000 board feet average or over or the approximate market value to the Contractor on lower value lumber. The Contractor agrees to return the advance as the lumber is sold. The Contractor further agrees to assist the Board's forester and/or a Coal Company representative in taking an accurate yard inventory on consecutively numbered pile bottoms near the 1st day of the month, said inventory and increases or decreases therefrom to be used as a basis for settlement between the Contractor and the Coal Company by the 8th day of the month.

The Contractor agrees that the maximum allowable advance under the paragraph shall be decreased by at least the sum of $2,000.00 on the 1st day of August of each succeeding year until this obligation is discharged.

8. Contractor shall assume and bear all risk of damage or injury to persons or property arising out of the performance of this agreement and shall hold and save the Coal Company harmless from and against all causes of actions, liens (statutory or otherwise) and any other claims or demands which may arise out of such performance. If any judgment, mechanic's or laborer's lien or other lien arising out of such performance shall be rendered or levied against the Coal Company or the Coal Company's property, or against the Board or the Board's property, the Contractor shall, at his own expense, satisfy and discharge the same. Contractor shall at all times during the term or any extended term of this agreement maintain in force a proper policy or policies of public liability insurance with personal injury and death limits of not less than $100,000.00 per person and $300,000.00 per accident and of property damage insurance with a limit of not less than $25,000.00 covering its activities and undertakings hereunder. A certificate of such coverage will be furnished to the Coal Company.

9. Nothing herein contained shall be construed as giving the Contractor the exclusive right to furnish the Coal Company with all the timber and/or lumber the Coal Company may require. The Coal Company reserves the right to contract with other persons or corporations for the furnishing to the Coal Company lumber or timber in any amount manufactured or produced from trees felled in any location, whether or not off the Coal Company's lands.

10. Contractor shall be responsible for forest fire control action within the area covered by this contract and adjacent areas of Coal Company property and shall take immediate and effective action with his entire crew to completely extinguish any fire which shall occur. Contractor shall fight such fires at no expense to the Coal Company or to the Board.

11. In the event the Contractor shall fail to make settlement with the Coal Company for the latter's share of the gross sale price of the lumber cut from the premises, all in accordance with Paragraph 6 above, the Coal Company shall have the right at once to declare this agreement forfeited and cancelled by giving the Contractor oral or written notice of such cancellation. Upon such cancellation Contractor shall forthwith cease all operations on the premises and the Coal Company shall have the right to proceed to collect all sums due to it by the enforcement of the lien granted to it under Paragraph 6, or by that certain deed of trust dated September 22, 1958, and of record in the Office of the Clerk of the Circuit Court of Mingo County, West Virginia, in Trust Deed Book No. 90, at page 36, or by such other action or proceedings as to it may

seem proper. The waiver by the Coal Company of any particular cause of forfeiture shall not prevent the forfeiture and cancellation of this agreement for any other cause of forfeiture or for the same cause occurring at any other time. At the end of the term of this agreement, and Contractor not being in default hereunder, the Contractor shall at once remove from the premises his sawmill, trucks, machinery, equipment, or other property. Either the Coal Company or the Contractor shall have the right without cause to cancel and terminate this agreement at the end of the term thereof or at any time by giving the other party ninty (90) days' written notice of its intention so to do. If neither party shall so notify the other party, this agreement shall be automatically renewed and extended for an additional term of one year, and from year to year thereafter, upon the same terms and conditions.

12. Upon completion of current cutting operations on the Experimental Forest, estimated to be early in 1961, the Contractor shall continue logging operations on other Company lands in Logan and/or Mingo Counties, as directed by the Company Forester. All prior provisions of this agreement shall apply on these other Company lands and shall be carried out under the direction of the Senior Company Forester.

13. The Board joins in the execution of this agreement for the purpose of evidencing its consent hereto, and agrees that the Board's Forester shall cooperate with and assist the Coal Company in the administration of this agreement, insofar as the Experimental Forest area is concerned.

WITNESS the following signatures and seals.

ISLAND CREEK COAL COMPANY

By.....
Vice-President

BOARD OF GOVERNORS OF WEST VIRGINIA UNIVERSITY, a corporation

By.....
President of the University and
Chief Executive Officer of the
Board of Governors

.....(Seal)
Raymond Carey

The undersigned, as owner of part of the forest lands described in the above grant, hereby consents thereto.

UNITED THACKER COAL COMPANY

By.....
Executive Vice President

EXHIBIT A

1. **Marking.** All dead timber standing or down shall be marked or designated for cutting by the Board's forester, by marking with distinctive yellow paint spots below stump height and at breast height. All trees so marked or designated shall be cut and all merchantable material shall be removed from the area. Also, any trees considered as unmerchantable and previously frilled and poisoned by the Board's forester may be cut at the option of the Contractor.

2. **Utilization.** Stumps shall be cut so as to cause the least practical waste and no higher than 12 inches on the side adjacent to the highest ground, except that when this requirement is impracticable in the judgment of the Board's forester, he may authorize and accept higher stumps; PROVIDED, that all stumps which are not cut in accordance herewith and which should have been so cut in the judgment of the

Board's forester, shall be paid for at the rate of $0.25 each. Such payment shall be regarded as liquidated damages, in part, in view of the difficulty of determining the actual damage.

3. **Logging Methods.** The operation of logging equipment shall be subject to such reasonable restrictions as the Board's forester may deem necessary for the forests' interests. Tractors with bulldozer blade will not be used in skidding without the permission of the Board's forester.

As far as practical, all branches of logging shall keep pace with one another and the sawmilling shall keep pace with the logging.

Operations begun on any portion of a cutting unit shall be completed in accordance with the terms of this agreement before cutting may begin on other areas, unless such cutting is authorized by the Board's forester, in which event cutting shall be completed on the area left unfinished as soon as practicable.

Logs cut from trees for high grade lumber shall be bucked into lengths of eight (8), ten (10), twelve (12), fourteen (14) and sixteen (16) feet, plus three (3) inches for trimming, and shall be cut so as to obtain as long lengths as possible, and yet remain reasonably straight.

No unnecessary damage shall be done to young growth or to trees left standing. Unmarked or undesignated trees which are badly damaged in logging shall be cut if required by the Board's forester.

4. **Merchantability.** Trees over 12 inches in diameter 4½ feet from the ground, which contain one merchantable 8 foot log shall be considered merchantable under the terms of this agreement.

Trees from 8 inches to 12 inches in diameter 4½ feet from the ground, which contain at least one twelve foot section to a minimum diameter of six inches shall be considered a merchantable prop tree.

Any log shall be merchantable that is 8 feet long to a minimum diameter of 10 inches. Any log having a 6" sound ring around a center hollow or defect, and affording adequate length, shall also be merchantable.

5. **Grading.** All gradelumber shall be cut to full length, shall be manufactured and shall meet grading requirements of the National Hardwood Lumber Association, and shall be graded by the Contractor when sold.

6. **Time Study.** The Contractor agrees to assist the Board's forester in a time study so that operating costs can be kept for the different methods of management, such assistance to be a daily verbal or written statement as to man hours spent on the various jobs and time spent by animals and mechanical equipment.

Contractor will maintain an adequate accounting system in accordance with good accounting principles and develop cost of operations.

7. **Construction Material.** Cull material shall be used for all improvements where practicable. All merchantable timber used in the construction of bridges, roads, skidroads, skidways, landings and other structures necessary in connection with the cutting and removal of the timber covered by this agreement shall be selected from market trees of an inferior quality as will meet this use.

8. **Cull Timber.** The Contractor agrees to cut all cull trees tallied and marked with a large "X" by the Board's forester. The Coal Company agrees to pay the Contractor the sum of twenty-five cents ($0.25) for said culls based on above tally as each logging unit is completed and all culls on that unit are cut.

9. **Other Conditions.** All telephone and power lines, ditches, oil or gas lines, fences, and other structures located within or immediately outside the exterior boundaries of the cutting units shall be protected so

far as possible in logging operations and, if injured, shall be repaired immediately by the Contractor. Roads and trails shall at all times be kept free of logs, brush, and debris resulting from the Contractor's operations hereunder, and any road or trail used by the Contractor in connection with this operation that is damaged or injured beyond ordinary wear and tear, through such use, shall promptly be restored by him to its original condition.

10. **Liquidated Damages.** The Contractor shall conduct all operations under this contract in a workmanlike manner, and shall not unnecessarily damage young growth or trees left standing.

Inasmuch as the unnecessary damage of cutting of undesignated trees, or the failure to cut and remove designated trees on portions of the cutting area cut over under this contract will cause serious substantial silvicultural or other damage to the experimental forest, and because it will be difficult, if not impossible, to determine the amount of such damage, the Contractor shall pay as fixed, agreed and liquidated damages therefor an amount **equivalent to** and **in addition to** the following estimated stumpage prices per thousand board feet, International scale: for Oak $3.00, Yellow Poplar and Cucumber $5.00, Beech $1.00, Basswood $5.50, Hard Maple $8.50, Hemlock $6.00, and all other species $2.00.

When, in the opinion of the Board's forester, the cutting of undesignated trees or the non-cutting of designated trees, or the non-removal of merchantable material from the cutting area is trivial in amount or justified by existing conditions, he may, at his discretion, waive the collection of liquidated damages as set forth in the immediately preceding paragraph of this contract.